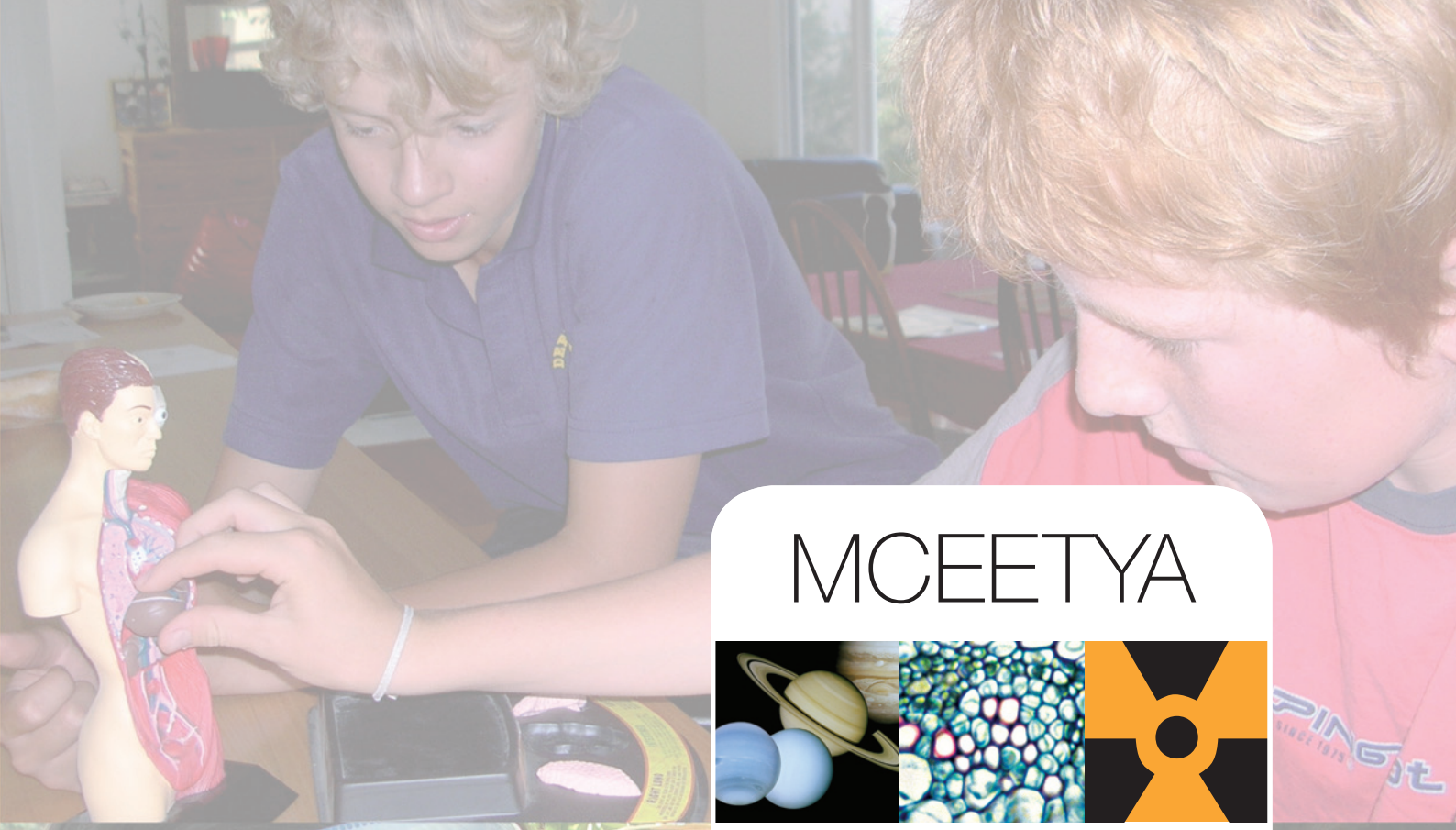

MCEETYA

National Assessment Program – Science Literacy Year 6 Technical Report

2006

MINISTERIAL COUNCIL ON EDUCATION,
EMPLOYMENT, TRAINING AND YOUTH AFFAIRS

NAP-SL 2006 Project Staff

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MINISTERIAL COUNCIL ON EDUCATION,
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National Assessment Program – Science Literacy 2006: Overview

1.1 Introduction

In July 2001, the Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA) agreed to the development of assessment instruments and key performance measures for reporting on student skills, knowledge and understandings in primary science. It directed the newly established Performance Measurement and Reporting Taskforce (PMRT), a nationally representative body, to undertake the national assessment program. The PMRT commissioned the assessment in July 2001 for implementation in 2003. The Primary Science Assessment Program (PSAP) – as it was then known – tested a sample of Year 6 students in all States and Territories. PSAP results were reported in 2005.

The National Assessment Program – Science Literacy was the first assessment program designed specifically to provide information about performance against MCEETYA's National Goals for Schooling in the Twenty-First Century. MCEETYA has since also endorsed similar assessment programs to be conducted for Civics and Citizenship, and Information and Communications Technology (ICT). The intention is that each assessment program will be repeated every three years so that performance in these areas of study can be monitored over time. The first cycle of the program was intended to provide the baseline against which future performance could be compared.

PMRT awarded the contract for the second cycle of science testing, for 2006, to a consortium of Educational Assessment Australia (EAA) and Curriculum Corporation (CC). Educational Measurement Solutions (EMS) was sub-contracted to CC to provide psychometric services.

The Benchmarking and Educational Measurement Unit (BEMU) was nominated by PMRT to liaise between the contractors and PMRT in the delivery of the project.

The Science Literacy Review Committee (SLRC), comprising members from all States, Territories and sectors, was a consultative group to the project.

1.2 Purposes of the Technical Report

This technical report aims to provide detailed information with regard to the conduct of the National Assessment Program – Science Literacy 2006 so that valid interpretations of the 2006 results can be made, and future cycles can be implemented with appropriate linking information from past cycles. Further, a fully documented set of the National Assessment Program – Science Literacy procedures can also provide information for researchers who are planning surveys of this kind. The methodologies used in the National Assessment Program – Science Literacy 2006 can inform researchers of the current developments in large-scale surveys. They can also highlight the limitations and suggest possible improvements in the future. Consequently, it is of great importance to provide technical details on all aspects of the survey.

1.3 Organisation of the Technical Report

This report is divided into nine chapters.

Chapter 2 provides an outline of the test development and test design processes, including trialling and item selection, and the assessment domains of scientific literacy.

The sampling procedures across jurisdictions, schools and classes are discussed in Chapter 3.

Chapter 4 includes information about how the tests were administered and marked, including coding for student demographic data and participation or non-inclusion. It also provides an explanation of the reporting processes.

Chapter 5 details the processes involved in computing the sampling weights.

Chapter 6 provides an extensive analysis of all items included in the final test forms, including item difficulties based on Rasch modelling.

Scaling and item calibration procedures leading to the placement of items and student scores within the Proficiency levels of the Scientific Literacy Progress Map are outlined in Chapter 7.

Chapter 8 discusses the processes used to equate the 2003 assessment and the 2006 assessment.

Chapter 9 provides information about the proficiency scale used for reporting the results, including the cut-scores for each of the levels and the placement of all test items within the levels.

Chapter 2
Test Development and Test Design

2.1 Assessment domains

The National Assessment Program – Science Literacy measures scientific literacy. This is the application of broad conceptual understandings of science to make sense of the world, understand natural phenomena and interpret media reports about scientific issues. It also includes asking investigable questions, conducting investigations, collecting and interpreting data and making decisions. The construct evolved from the definition of scientific literacy used by the Organisation for Economic Co-operation and Development (OECD) Programme for International Student Assessment (PISA):

> *... the capacity to use scientific knowledge, to identify questions and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity.*
>
> (OECD 1999, p. 60)

A scientific literacy assessment domain was developed for the assessment in consultation with curriculum experts from each State and Territory and representatives of the Catholic and independent school sectors. This domain includes the definition of scientific literacy and outlines the development of scientific literacy across three main areas.

Three main areas of scientific literacy were assessed:

Strand A: formulating or identifying investigable questions and hypotheses, planning investigations and collecting evidence

Strand B: interpreting evidence and drawing conclusions from their own or others' data, critiquing the trustworthiness of evidence and claims made by others, and communicating findings

Strand C: using science understandings for describing and explaining natural phenomena and for interpreting reports about phenomena.

A conscious effort was made to develop assessment items that related to everyday contexts.

The scientific literacy domain is detailed in Appendix A. The items drew on four concept areas: Earth and Beyond (EB); Energy and Change (EC); Life and Living (LL); and Natural and Processed Materials (NP). These major scientific concepts are found most widely in curriculum documents across all States and Territories and were used by item writers to guide test development. The list of endorsed examples for each of these major concepts is in **Table A.2**.

The intention was to ensure that all Year 6 students were familiar with the materials and experiences to be used in the National Assessment Program – Science Literacy and so avoid any systematic bias in the instruments being developed.

2.2 Test blueprint

In 2005 MCEETYA published a Response for Tender (RFT) document. Consequently, EAA/CC developed the following proposal for the tests:

> *It is anticipated that the 2006 final test forms will contain approximately 100 items in total (excluding link items from 2003) providing sufficient assessment items for up to two hours of testing for each student in the national sample. This number of items will also provide items to form part of the assessment kit to be released for teacher use and items to be held secure for 2009.*
>
> *The total number of new items to be developed for trial is estimated at 275 (the item pool), based on developing and trialling 2.5 times the number of items required for the final test forms. This allows for maximum flexibility through the review process when various criteria are applied to each item to assess item suitability for retention in the item pool. It was proposed that 25 items from 2003 be embedded in the 2006 test as link items. Ultimately, eleven items were approved for use as link items in the main test. These are summarised in **Table 8.1** on page 68. In the final test nine items from 2003 were included.*
>
> *The following diagram indicates a proposed composition of the instruments that will enable coverage of a wide range of student performance over the three strands of science literacy, and thus also provides an outline of the test specifications.*

Figure 2.1 Proposed composition of the National Assessment Program – Science Literacy item pool across strands A, B and C

Level	Strand A	Strand B	Strand C
1	5%	5%	5%
2	15%	15%	15%
3	35%	35%	35%
4	30%	30%	30%
5	15%	15%	15%
6	0%	0%	0%

> *… It is proposed that there be three types of items developed: multiple-choice items; short constructed-response items (requiring one- or two-word responses from students); and constructed-response items requiring students to provide an extended response. For Year 6 students an extended response might reasonably be expected to be of the order of one or two sentences – up to a short paragraph – if in text form, or a diagram or constructed data table of equivalent detail.*
>
> *The balance of item types within the trial item pool is proposed to be: 50% multiple-choice; 10% short constructed-response; 40% extended constructed-response. This balance is proposed on the basis that it is acknowledged that Year 6 students may be reluctant to provide overly lengthy written explanations to test questions. However, in order to assess the higher-order skills demanded by upper levels of the framework, it will be necessary to include some extended response items.*
>
> *Due to the contextualised nature of the paper-and-pencil units and practical tasks, it is expected that the majority of units will contain a mix of item types.*

This proposal was accepted and implemented, as outlined below.

2.2.1 Test design

In order to cover a wide range of content areas in science, but at the same time not to place too much burden on each student, a balanced incomplete block (BIB) rotated test booklet design was preferred. A BIB rotational design minimises the effect of biased item parameters caused by varying item positions arising from the placement of an item in a test booklet. In this design, items are placed in 'clusters' and the clusters are rotated through the test forms, each appearing three times, each time in a different location in the test form. Seven test forms were agreed to for the final test; ten for the trial. **Table 2.1** demonstrates the BIB design used for the National Assessment Program – Science Literacy 2006.

Table 2.1 BIB design used in the National Assessment Program – Science Literacy 2006

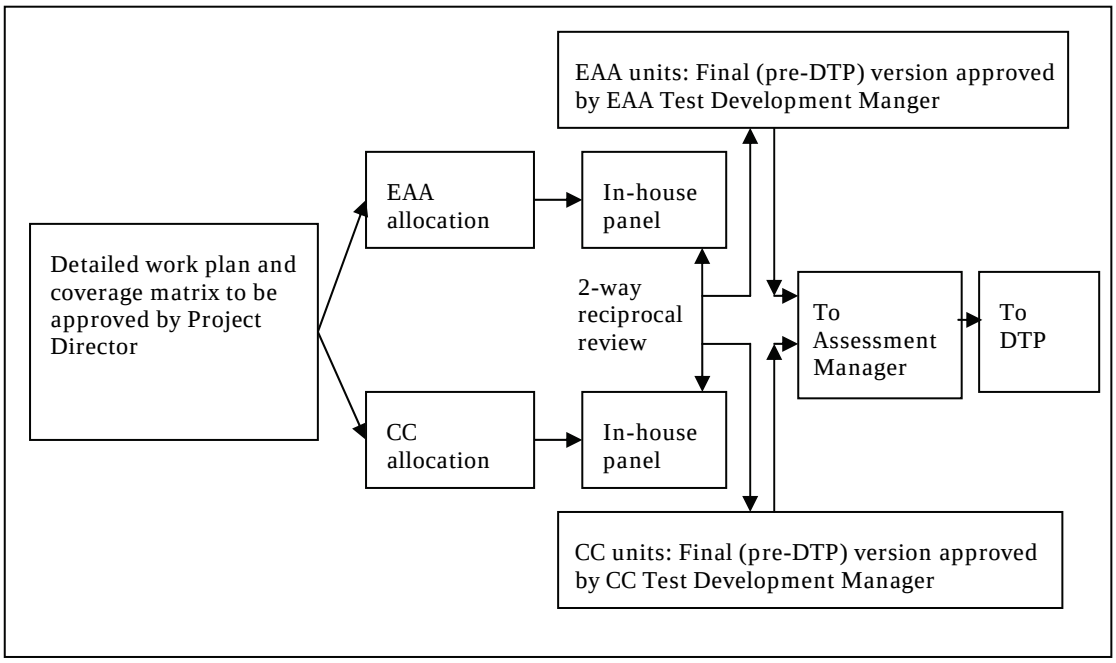
Booklet	Block 1	Block 2	Block 3
1	Cluster 1	Cluster 2	Cluster 4
2	Cluster 2	Cluster 3	Cluster 5
3	Cluster 3	Cluster 4	Cluster 6*
4	Cluster 4	Cluster 5	Cluster 7
5	Cluster 5*	Cluster 6	Cluster 1
6	Cluster 6	Cluster 7	Cluster 2
7	Cluster 7	Cluster 1	Cluster 3

* The Energy Transfer unit from Cluster 5 does not appear in Booklet 5, but instead appears at the end of Cluster 6 in Booklet 3.

2.3 Test development process

Test development was undertaken by both EAA and CC. A process was developed to facilitate item writing in prescribed batches which were swapped between the organisations for refinement and review (as per flow chart below).

Figure 2.2 Test development flow chart



Specifications for trialling required the development of a total of 275 items, including 200 objective questions and 75 questions attached to 5 practical tasks.

Table 2.2 Proposed composition of the National Assessment Program – Science Literacy item pool across concept areas

Strand	Number of items		Total number of items	% breakdown EB, EC, LL, NP
	Paper and pencil tasks	Practical tasks		
EB	50	15	65	25
EC	50	15	65	25
LL	50	15	65	25
NP	50	15	65	25
	200	60 [+ 15*]	260 [+15*] = 275	100

* Additional 15 practical items across the four concept areas

Each practical task was piloted with at least two classes of students to ensure that the activities proposed and the associated administration procedures could be implemented with ease in the Year 6 classroom setting. A total of six schools participated in this pilot. The piloting also established the degree to which the proposed tasks were engaging for students. Given the potentially limited access to science equipment, and associated lack of familiarity of students with equipment more likely to be found in secondary school laboratories, all materials required for the conduct of the tasks were relatively simple in nature and were provided to schools.

The coverage of levels and strands was to be as follows:

Item distribution across strands (strand weightings): Process 40% (Strand A: 20% and Strand B: 20%); Concept 60%

Table 2.3 Proposed composition of the National Assessment Program – Science Literacy item pool across levels and strands

Level	Strand A: number of items	Strand B: number of items	Strand C: number of items	Total number of items	% (of 275 items)
1	3	3	8	14	5
2	8	8	25	41	15
3	19	19	58	96	35
4	17	17	49	83	30
5	8	8	25	41	15
6	0	0	0	0	0
Total	55	55	165	275	100

Distribution of item types was to be 50% multiple choice; 10% one- or two-word response (to be editor-marked); 40% extended constructed-response (teacher-marked).

In response to these requirements, EAA and CC developed ten trial test books of objective items, and five trial practical tasks. The items were placed into clusters that were arranged into the trial forms so that each cluster appeared twice.

The trial forms contained a cluster (Cluster 9) of link items drawn from the secure item pool from 2003. These items were included to inform the equating study.

Descriptors were written for each item and a draft marking key was developed. The marking guide included possible responses to constructed response questions.

The final pool of trial items developed was presented to the Science Literacy Review Committee (SLRC).

Table 2.4 Composition of the trial item pool (all released batches)

	Released total pool	Pen-and-paper units	Practical tasks	Total pool target
Sum of major concept area EB	68	54	13	65
Sum of major concept area EC	65	49	16	65
Sum of major concept area LL	85	70	15	65
Sum of major concept area NP	83	55	29	65
	301			275
Sum of major concept EB.1	9	9	0	23
Sum of major concept EB.2	20	20	0	23
Sum of major concept EB.3	38	25	13 (Gravity effects)	23
Sum of major concept EC.1	19	19	0	23
Sum of major concept EC.2	26	10	16 (Energy)	23
Sum of major concept EC.3	20	20	0	23
Sum of major concept LL.1	23	23	0	23
Sum of major concept LL.2	41	22	0	23
Sum of major concept LL.3	22	26	15 (Adaptations)	23
Sum of major concept NP.1	57	28	29 (Stretch; Properties)	23
Sum of major concept NP.2	15	15	0	23
Sum of major concept NP.3	12	11	0	23
Sum of strand A	35 (12%)	11	23	55 (20%)
Sum of strand B	123 (41%)	93	31	55 (20%)
Sum of strand C	143 (48%)	124	19	165 (60%)
Sum of level 1	12 (4%)	3	9	14 (5%)
Sum of level 2	36 (12%)	30	6	41 (15%)
Sum of level 3	131 (44%)	103	27	96 (35%)
Sum of level 4	106 (35%)	80	29	83 (30%)
Sum of level 5	13 (5%)	11	2	41 (15%)
Sum of item type MC	106 (35%)	92	14	138 (50%)
Sum of item type CR	128 (43%)	70	58	110 (40%)
Sum of item type EM	67 (23%)	66	1	27 (10%)

2.4 Field trial of test items

Students from 31 selected schools across NSW, ACT, VIC and SA participated in the trial in October 2005. The trial schools were selected to reflect the range of educational contexts around the country, and included government, non-government and Catholic; low and high socioeconomic drawing areas; metropolitan and regional; large and small; high and low LBOTE population etc.

In total approximately 1100 students from the trial schools across the four selected States participated in the trial. Each student completed one of the ten trial objective test papers and one of the five practical tasks. Within each class, teachers were asked to evenly distribute the ten objective test forms amongst students. On completion of the objective forms students within a class were asked to separate into groups of three (or groups of two where necessary) for completion of the practical task. Students within the one class completed the same practical task.

Classroom teachers were provided with an administration manual in advance of the trial to allow them to familiarise themselves with the test procedures. An invigilator was sent to each trial school to deliver and collect the materials (to ensure the security of the materials) and to also observe and support the classroom teacher throughout the assessment. At the completion of each session the invigilator completed a session report form in conjunction with the classroom teacher, to provide feedback about various aspects of the trial. This feedback, in conjunction with a range of other sources of feedback, informed the selection and refinement of items for the final pool.

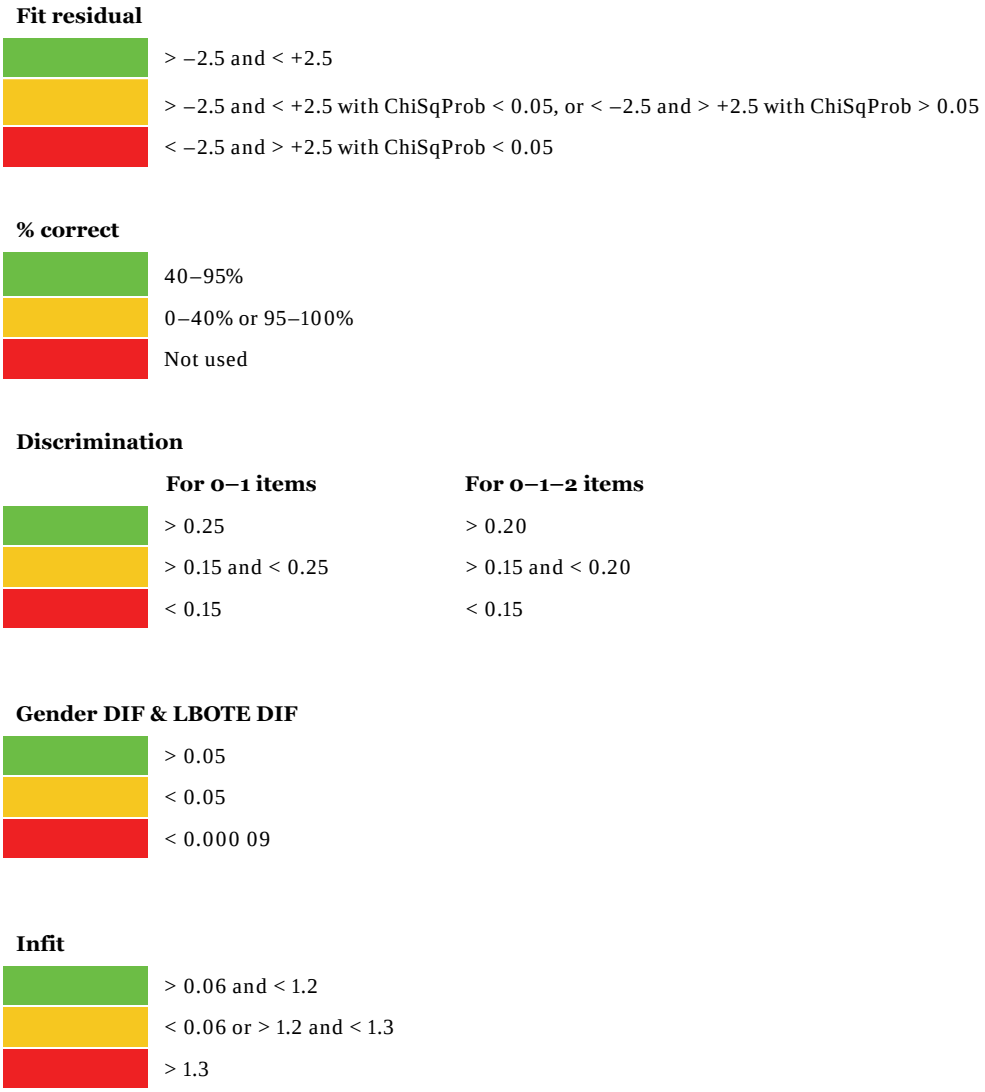
A team of experienced markers was engaged for a one-week period. Test developers from both EAA and CC trained the markers and remained on-site to oversee the marking process. On completion of marking of each cluster or practical task, a debrief session with the test developer trainer was held and updates were made to marking guides.

2.4.1 Analysis of the trial

In the first instance, the trial scores were data-entered and analysed by EAA's data analysis team. An initial analysis using RUMM software was run, then the dataset was supplied to EMS who ran an analysis using Quest. The results of the parallel analyses were consistent. The analyses were compiled onto a spreadsheet and a colour coding ('traffic light') system was implemented to act as a broad indicator of each item's performance (see **Figure 2.3**).

Key criteria for judging the performance of items were discrimination and measures of fit. Percentage correct was noted but only informed a decision to eliminate an item if other statistics were poor. Differential Item Functioning (DIF) for gender and Language Background Other Than English (LBOTE) were also considered.

Figure 2.3 Colour key for judging the performance of items



EAA and CC examined the item statistics separately and together and agreed to remove a number of items with poor fit or discrimination (**Table C.1** details inclusions and exclusions). It was agreed that the remaining items (230) be provided to the SLRC for their feedback and suggestions about which other items could be deleted from the final pool. Items with DIF were flagged but not automatically discarded.

Differential Item Functioning

By definition, Differential Item Functioning refers to groups of students responding to an item differently, after adjusting for the groups' overall ability. For example, if a boy and a girl have the same ability, but the probability of success on an item for the girl is higher (or lower) than the probability of success for the boy, then the item exhibits DIF. DIF does not refer to the difference in raw percentages correct for the groups, since these differences could be due to the fact that the groups have varying abilities. In other words, DIF examines the performance of a group on an item relative to their performance on other items. Consequently, if some

items show DIF favouring one group, there must be other items showing DIF against that group. In this respect, a study of DIF shows the relative differences in performance on items in one test. DIF does not show 'absolute' differences between two groups of students.

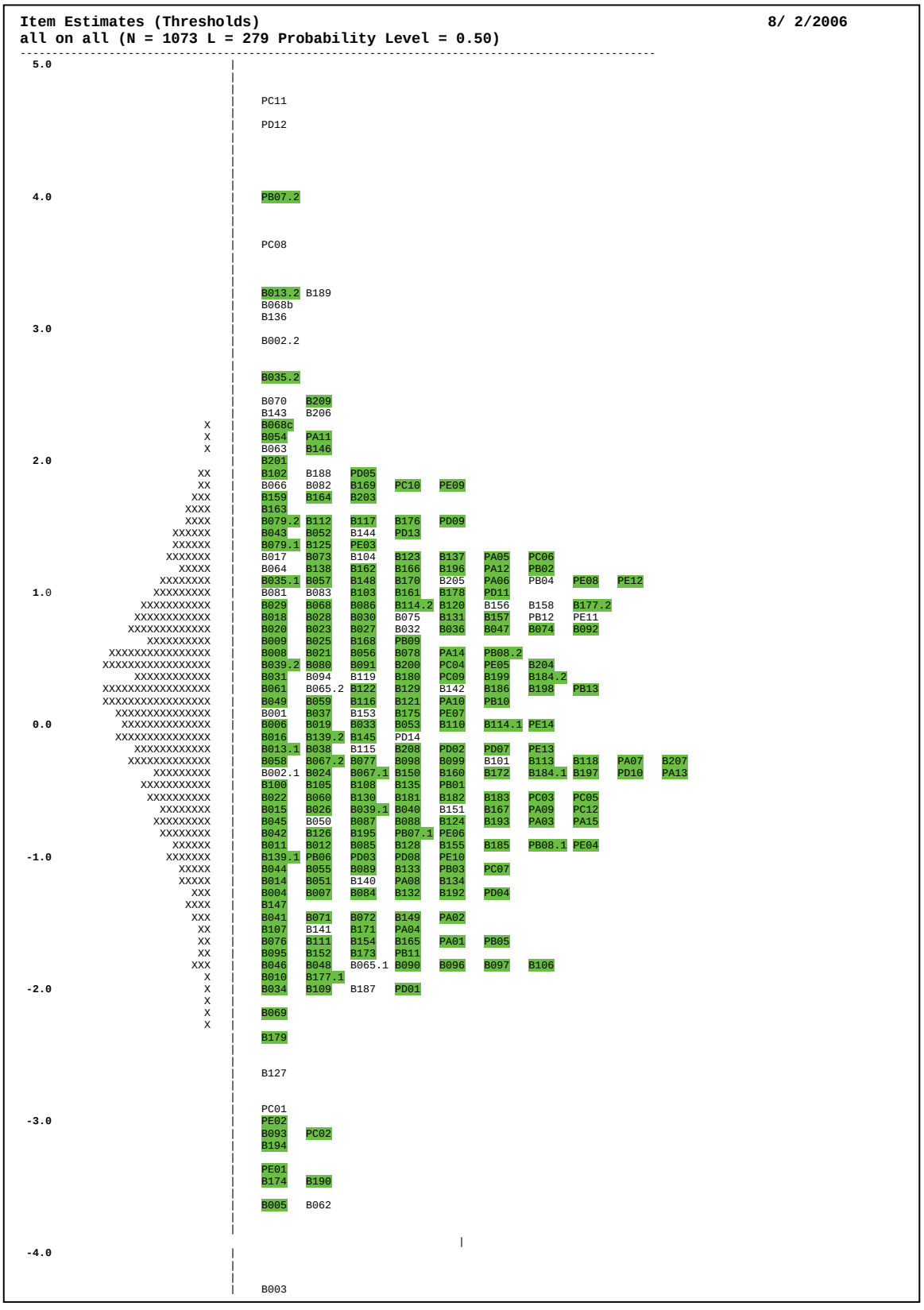
The DIF analyses for the National Assessment Program – Science Literacy were carried out using ConQuest by fitting a facets model where the interaction between an item and gender group is estimated. When the interaction term is significantly different from zero at 95% confidence level, an item is deemed to be showing DIF.

Items exhibiting DIF should not be automatically removed simply based on statistical evidence of bias. They should only be removed based on substantive reasoning. In some cases, it may well be the case that girls and boys do not perform in the same way across content areas in a subject domain, and such differential performance may be expected. Judgments should be made based on the importance of the skills tested in the specific items, and whether the inclusion of items showing DIF will bias the results in ways that are not consistent with the aims of the assessment.

The DIF findings were brought to the attention of subsequent reviewers (e.g. BEMU and SLRC), to inform final item selection.

Figure 2.4 shows an item map produced from Quest output illustrating diagrammatically the distribution of all trialled items (indicated by item identifiers), and those comprising the 230 post-trial pool (shaded). The purpose of this diagram was to provide 'at a glance' the range of difficulty of the items and how they aligned with the ability of students in the trial pool (each 'X' represents three students). As can be seen, there were a number of items that all students found to be very easy, a number of items that were challenging (even for the most able students) and many items in the middle range.

Figure 2.4 Item map for 230 post-trial items



The range of item difficulty was approximately 10 logits for the pool of 230 items.

The range of items was examined and acceptable levels for item difficulty were proposed:

Table 2.5 Suggested logit range for acceptable difficulty for each level

	Level 5	Level 4	Level 3	Level 2	Level 1
Location	>1.0	0 to 2.0	–1.0 to 1.0	–2.0 to 0	< –2.0

Notes:

- For Level 5, the small number of cases precludes suggesting upper limit.
- For Level 1, the small number of cases precludes suggesting lower limit.

The purpose of proposing such levels was to check that levels initially ascribed to items were confirmed by the data analysis: were Level 1 items the easiest items and were Level 5 items the most difficult? Items that appeared to fall outside the proposed ranges were flagged for further scrutiny of item demand and possible reclassification.

The entire analysis of trial items, including deleted items and comments, was provided to BEMU for their reference.

2.4.2 Reports to trial schools

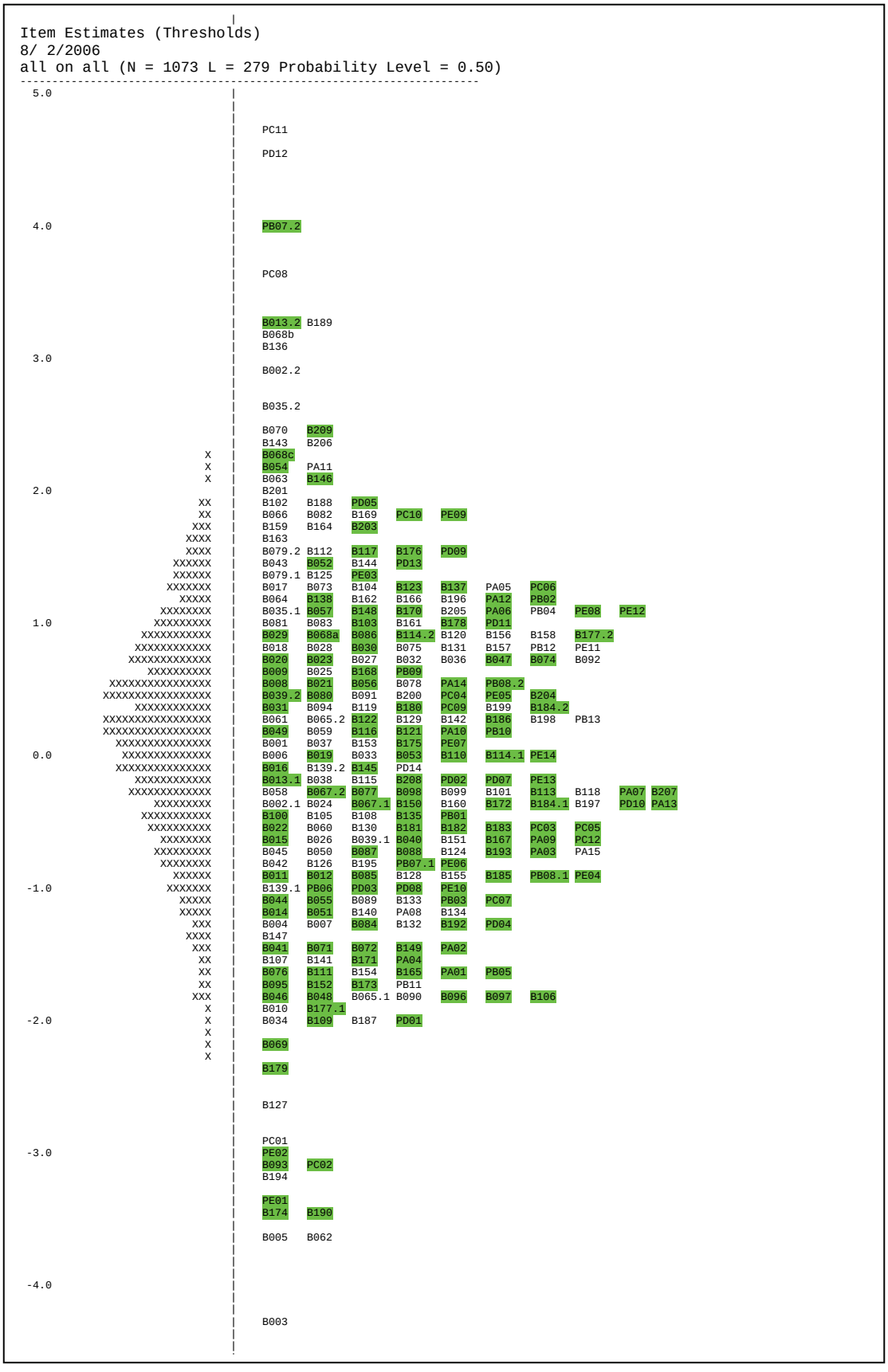
Reports were developed and provided to schools that had participated in the trial. The reports were received in schools in December 2005. They contained ten A4 sheets: one for each of the ten test booklets used in the assessment. Individual students' results were given for the test booklet which they completed in the assessment. In addition there was a school report for each of the practical tasks conducted by the school. An information sheet providing advice on interpreting the reports was also included.

2.5 Item selection process for the final test

Items that were retained after the trial process for further consideration as possible items for the final test pool were provided to the SLRC via a website. Reviewers using a login and password could examine each item and then rank it in order of priority for its inclusion in the final test. There was a field available for comments. Reviewers could click tabs to open up psychometric detail about the trial analysis, the stimulus, the key or marking guide and acceptable responses for constructed response items. SLRC members could enlist groups of people to review the items and then group the responses as the feedback from the jurisdiction represented.

Figure 2.5 illustrates diagrammatically the distribution of all trialled items (indicated by item identifiers) and those comprising the post-SLRC feedback pool items (shaded). As for **Figure 2.4**, each 'X' represents three students in the trial.

Figure 2.5 Item map for 204 post-SLRC review items



EAA and CC met to review the SLRC feedback and further reduced the item pool. In addition, EAA and CC independently developed draft final lists of preferred test items for 2006 which were then exchanged and compared. The final pool containing 110 items was agreed as reflecting the best balance of items against the original specifications.

A final pool of potential test items was presented to an SLRC meeting and approved for use in the 2006 testing. The final pool included 11 link items from 2003 from the 18 that had been used in the trial (see Appendix C).

2.6 Test characteristics of the final test

The actual distribution of items across the assessment domain for scientific literacy (strands and major concept areas) is shown in **Table 2.6**. There were 110 items distributed across the seven pencil-and-paper tests and two practical tasks. Each student had to sit for one pencil-and-paper test and one practical task.

Table 2.6 Composition of the final item pool

Domain	Item type and number of items			
	Multiple-choice (MC)	Short-answer (SA)	Extended-response (ER)	Total
Distribution of items by strand				
Strand A	2	0	6	8
Strand B	31	3	17	51
Strand C	16	10	25	51
Total	49	13	48	110
Distribution of items by major science concept area				
Earth and Beyond (EB)	23	1	13	37
Energy and Change (EC)	3	4	8	15
Life and Living (LL)	12	3	21	36
Natural and Processed Materials (NP)	11	5	6	22
Total	49	13	48	110

The final composition of the items (110) going forward to the sample test is shown by the series of tables below.

Table 2.7 Breakdown of concept areas across the final objective and practical papers

Paper type	Concept area				Total
	EB	EC	LL	NP	
Objective	28	15	26	22	91
Practical	9		10		19
Total	37	15	36	22	110

Table 2.8 Breakdown of strands across the final objective and practical papers

Paper type	Strand			Total
	A	B	C	
Objective	4	41	46	91
Practical	4	10	5	19
Total	8	51	51	110

Table 2.9 Breakdown of levels across the final objective and practical papers

Paper type	Level					Total
	1	2	3	4	5	
Objective	3	13	44	28	3	91
Practical	2	2	10	5		19
Total	5	15	54	33	3	110

Table 2.10 Breakdown of item types across the final objective and practical papers

Paper type	Item type			Total
	ER	SA	MC	
Objective	33	13	45	91
Practical	15		4	19
Total	48	13	49	110

Table 2.11 Breakdown of major concepts across the levels within the final item pool

Major concept	Level					Total
	1	2	3	4	5	
EB.1		1	3	1	1	6
EB.2	1		5	2		8
EB.3	1	3	8	10	1	23
EC.1		2		3		5
EC.2			2	1		3
EC.3			5	2		7
LL.1			5	3		8
LL.2			3	1		4
LL.3	1	4	13	5	1	24
NP.1	2	2	6	3		13
NP.2		3	3	1		7
NP.3			1	1		2
Total	5	15	54	33	3	110

Table 2.12 Breakdown of location ranges (based on trial statistics) across the final objective and practical papers

Paper type	Location ranges														Total
	−4.0 to −3.5	−3.5 to −3.0	−3.0 to −2.5	−2.5 to −2.0	−2.0 to −1.5	−1.5 to −1.0	−1.0 to −0.5	−0.5 to 0.0	0.0 to 0.5	0.5 to 1.0	1.0 to 1.5	1.5 to 2.0	2.0 to 2.5	2.5 to 3.0	
Objective	2	1	2	1	11	7	15	10	13	18	5	3	2	1	91
Practical			1		1	1	6	2	3	1	3	1			19
Total	2	1	3	1	12	8	21	12	16	19	8	4	2	1	110

2.7 Reports to schools

Reports were developed and provided to schools that had participated in the sampling, and were based on the reports used at trial. The reports were received in schools in December 2006. They contained seven A4 sheets: one for each of the seven test booklets used in the final assessment. Individual students' results were given for the test booklet which they completed in the assessment. In addition there was a school report for each of the practical tasks conducted by the school. An information sheet providing advice on interpreting the reports was also included.

A sample school report is attached at Appendix B. Only one copy of the report for practical tasks and one copy of the report for the objective booklets have been included.

Chapter 3
Sampling Procedures

3.1 Overview

The desired (target) population for the National Assessment Program – Science Literacy consisted of all students enrolled in Year 6 in Australian schools in 2006.

As defined in the tender specifications, the number of students sampled in each jurisdiction was to be determined with the following considerations in mind:

It was desirable that the estimated mean scores for all jurisdictions were of similar precision. While this was an ultimate goal, it was recognised that reduced sample sizes would be needed for the smaller jurisdictions (i.e. ACT, NT and TAS). This is because most schools in the smaller jurisdictions will need to participate to form a large enough sample. As there are a number of national and international assessment projects implemented in Australia, many schools from the smaller jurisdictions will need to participate in multiple assessment projects, and consequently there will be too much administrative burden on the schools, particularly for the smaller schools.

Due to budgetary constraints, the nationwide achieved sample was to be approximately 12 000 students located within approximately 600 schools throughout Australia.

Accordingly, the 2006 sample differed from that drawn in 2003 in the following ways:

The sample frame, by definition, is more closely aligned to the national desired population than the sample frame in 2003, since the 2006 sample frame contained very small and very remote schools that were excluded in 2003.

Target sample sizes across the jurisdictions have been determined so that the precisions of estimates are as similar across jurisdictions as possible.

ACT, TAS and NT all had smaller sample sizes compared to other States, but their sample sizes were comparable or larger than their corresponding sample sizes in 2003.

The target sample sizes for the larger jurisdictions (NSW, VIC, SA, WA and QLD) were reduced in 2006 compared to those of 2003.

The total achieved sample size for 2006 was 12 911. This was smaller than the total achieved sample size for 2003 (14 172).

The sample design for the National Assessment Program – Science Literacy was a two-stage stratified[1] cluster sample. Stage 1 consisted of selecting schools that had Year 6 students. In this stage, schools were selected with probabilities proportional to their measure of size[2]. This selection procedure is referred to as 'probability proportional to size' (PPS) sampling. Stage 2 involved the random selection of an intact Year 6 class from the sampled schools selected in Stage 1.

3.2 Target population

The operational definition of the target population was a sampling frame which consisted of a list of all Australian schools and their 2005 Year 6 enrolment sizes as supplied by BEMU.

Generally, large scale sampling surveys of this type include provisions for excluding schools *before* sampling of schools takes place. This might be for reasons such as the school being located in geographically remote locations or of extremely small size. This approach was taken in 2003. In 2006, it was deemed desirable to include as many schools in the defined population as possible. Essentially this meant there were to be no school-level exclusions from the supplied sampling frame prior to sample selection. As such, the nationally defined population for the National Assessment Program – Science Literacy 2006 was more inclusive than the 2003 defined population[3]. However, the inclusion of schools that would previously have been excluded was expected to result in an increased non-response rate for 2006 compared to 2003. Consequently, a slightly inflated sample size would be required to deal with this expected increase in non-response rate at the school level, so that the actual achieved number of schools and students in the sample was adequate.

Additionally, schools were excluded in 2003 if their estimated enrolment size was fewer than five students because group work required a minimum of five students to complete the practical task (PSAP 2003, section 2.3). In contrast, in 2006, if a small school (fewer than five

[1] Stratification involves ordering and grouping schools according to different school characteristics (e.g. State, sector, urban/rural) which helps ensure adequate coverage of all desired school types in the sample.

[2] The school measure of size is related to estimated enrolment size of Year 6 students at the school.

[3] In 2003 very small and very remote schools were excluded from the sample frame, but this was not the case in 2006.

students) was selected, then this school was only required to complete the paper-and-pencil tasks. In this way, very small schools were not excluded from the survey.

3.3 School and student non-participation

In large scale surveys of this kind it is important to document reasons for non-participation so that interpretations of the main findings from the study can be appropriately made within the contexts of the survey. Examples of non-participation include remoteness, parental objection etc. As for the 2003 survey, the 2006 study made provisions to document the reasons for school/student non-participation. **Figure 3.1** illustrates the non-participation categories documented in the 2006 study whilst **Table 3.1** details the exemption and refusal categories for non-participating schools and students.

Figure 3.1 The National Assessment Program – Science Literacy 2006 non-participation categories

exemptions: exercise of principals' prerogative, subject to guidelines provided; and

refusals: specific parent objection to this form of assessment and consequential withdrawal of students from the program.

Table 3.1 The National Assessment Program – Science Literacy 2006 Exemption and Refusal codes

Code	Category description
11	Not included; functional disability. Student has a moderate to severe permanent physical disability such that he/she cannot perform in the NAP–SL testing situation. Functionally disabled students who can respond to the assessment should be included.
12	Not included; intellectual disability. Student has a mental or emotional disability and is cognitively delayed such that he/she cannot perform in the NAP–SL testing situation. This includes students who are emotionally or mentally unable to follow even the general instructions of the assessment. Students should NOT be excluded solely because of poor academic performance or disciplinary problems.
13	Not included; limited assessment language proficiency. The student is unable to read or speak any of the languages of the assessment in the country and would be unable to overcome the language barrier in the testing situation. Typically a student who has received less than one year of instruction in the languages of the assessment may be excluded.
14	Not included; parent requested that student not participate OR student refusal.

3.4 Sampling size estimations

To estimate the required sample size for each State/Territory, the key consideration is the required degree of precision for the mean estimate of science literacy for each State/Territory. As with many international studies of this kind, the stipulated precision for the estimated mean score for each State/Territory is that the 95% confidence interval around the estimated mean score should be within +/– 0.1*s*, where *s* is the standard deviation of science literacy ability distribution in each jurisdiction. This degree of precision for the mean score corresponds to an effective sample size of 400 students. That is, if a simple random sample is taken, the required precision will be achieved with a sample size of 400. As with surveys of

this kind, simple random samples are usually not used because of logistical difficulties in administering tests in potentially 400 different locations. Consequently, less efficient sampling methods will be used, and the required sample size will need to be larger than 400. More specifically, when the design effect[4] of the sample design is taken into account, the required sample size for each State/Territory is given by:

$$n_c = n^* \times deff \qquad (1)$$

where n_c is the required sample size, n^* is the effective sample size, and $deff$ is the design effect.

In the 2006 National Assessment Program – Science Literacy proposal, the required sample size was set at 12 000 students (down from 14 000 in 2003).

Table 3.2 shows the achieved sample size for 2003, the effective sample size and corresponding design effect for each jurisdiction. Using these figures together with the 2003 response rates, the target sample sizes required for 2006 were estimated.

Table 3.2 2003 and 2006 (target) jurisdiction sample size

State/ Territory	Actual achieved 2003 sample size	Effective 2003 sample size	Design effect	Desired effective sample size for 2006	Target achieved sample size for 2006	2003 response rate[5]	Proposed 2006 sample size to draw
ACT	854	297	2.88	400	1150	0.82	1402
NSW	2466	570	4.33	400	1731	0.88	1968
NT	496	155	3.20	400	1280	0.73	1757
QLD	2607	669	3.90	400	1559	0.93	1677
SA	2032	652	3.12	400	1247	0.72	1722
TAS	1240	314	3.95	400	1580	0.90	1755
VIC	2130	559	3.81	400	1524	0.77	1982
WA	2347	440	5.33	400	2134	0.83	2556
Total	13 318				12 203		14 821

Table 3.2 shows that the 2003 sample size in NSW, VIC and QLD could be reduced and still achieve the sampling precision required (assuming the design effect would remain relatively constant). This approach was adopted in 2006 to address the need to obtain estimates that were as accurate as possible while still operating within practical constraints.

[4] The design effect is the ratio of the sampling variance, under the method used, to the sampling variance if a simple random sample had been chosen. That is, design effect is a measure of the loss of sampling efficiency.

[5] Computed from the response rates in 2003 (see Table 2.1 of PSAP technical report).

The calculation of the 2006 proposed target sample size was based on the observed 2003 participation rates and design effects for each of the jurisdictions. There was some suggestion that the participation rates for 2006 would be higher than for 2003, as schools were given directives in 2006 from the government about the importance of participation. However, participation rates were not anticipated to increase overall from 2003 given that the defined population included schools that would have been excluded from the sampling frame in 2003.

It was not known how stable the estimated 2003 design effects would be and, as such, approximate averages were used to estimate target sample sizes rather than specific jurisdiction values. In 2003 the average observed design effect was 3.815 across the jurisdictions and the average response rate was 82%. These figures were used to guide the computation of desired 2006 sample sizes. That is, the proposed target sample size for each jurisdiction assumed that the overall response rate was equal to 85% and there was a design effect equal to 4.

Table 3.3 shows the proposed target student and school sample sizes for 2006. Note that sample sizes were reduced for ACT, NT and TAS as for PSAP 2003, and this reduction would result in greater sampling errors for these jurisdictions.

Table 3.3 Proposed 2006 sample sizes for drawing samples

State/Territory	Students	Schools
ACT	1400	59
NSW	2100	92
NT	950	50
QLD	2100	93
SA	2100	95
TAS	1400	64
VIC	2100	92
WA	2100	95
Total	14 250	640

Table 3.4 shows the number of educational institutions and students in the sampling frame for each jurisdiction, as provided by BEMU.

Table 3.4 Estimated 2006 Year 6 enrolment figures as provided by BEMU

State/Territory	Institutions	Students	Student %
ACT	108	4364	2
NSW	2345	86 961	33
NT	148	3002	1
QLD	1378	55 712	21
SA	618	18 837	7
TAS	223	6462	2
VIC	1805	64 405	24
WA	872	27 673	10
Total	7497	267 416	100

3.5 Stratification

The sampling frame was partitioned into 24 separate school lists with each list being a unique combination of State/Territory (8) and school type (3 – government, Catholic and independent). This explicit stratification was performed to ensure that an adequate number of students were sampled from each school type in each jurisdiction.

Within each of the separate strata, schools were ordered (implicitly stratified) firstly according to their geographic location[6] and then according to their measure of size which was related to the estimated number of Year 6 enrolments[7].

For most schools, the measure of size (MOS) for a school was set to the 2005 Year 6 enrolment size (ENR) of the school. A school's MOS was adjusted if the school had a small or, alternatively, a very large number of Year 6 students. Whilst sampling methods for both these school types are described in more detail in the subsequent sections, in general small schools had their MOS adjusted so that their selection in the sample would not result in excessively large sampling weights. In addition, very large schools had their MOS reduced so that they were not selected more than once.

The sample selection procedures were based on the target cluster size (TCS) which was an estimate of the average classroom size in Australia. The TCS was set at 25 which was the same as for 2003 (PSAP 2003, section 2.2). Schools with an enrolment size less than the TCS had a MOS set to the average enrolment size of the same category of small schools within each jurisdiction. This was performed to prevent excessively large sampling weights and was only applied after stratification had occurred.

[6] MCEETYA definition.

[7] The original Year 6 (gr06) variable was used to estimate the total number of students overall and per stratum. For the sample selection, the Year 6 estimated enrolment size (gr06) was initially rounded to the nearest whole number for each school.

3.5.1 Small schools

If a large number of schools were sampled that had enrolment sizes (ENR) less than the TCS, then the actual number of students sampled could be less than the overall target sample. Schools with enrolment sizes less than the TCS are classified as small schools in both PISA (2003) and TIMSS (2003). Both studies have different approaches for the treatment of small schools within the sampling frame. In 2006 National Assessment Program – Science Literacy, PISA (2003) guidelines were utilised for classifying and stratifying small schools, whilst an adapted version of TIMSS' (2003) treatment of small school MOS values was used.

Table 3.5 Proportions of schools by school size and jurisdiction

State/ Territory	School size	Number of schools	% schools	Number of students	% students
ACT	Large	69	64	3766	86
	Moderately small	26	24	515	12
	Very small	13	12	83	2
	Total	108	100	4364	100
NSW	Large	1394	59	76 913	88
	Moderately small	360	15	6712	8
	Very small	591	25	3336	4
	Total	2345	100	86 961	100
NT	Large	53	36	2256	75
	Moderately small	21	14	363	12
	Very small	74	50	382	13
	Total	148	100	3001	100
QLD	Large	747	54	49 652	89
	Moderately small	204	15	3662	7
	Very small	427	31	2397	4
	Total	1378	100	55 711	100
SA	Large	322	52	15 259	81
	Moderately small	140	23	2580	14
	Very small	156	25	999	5
	Total	618	100	18 838	100
TAS	Large	117	52	5145	80
	Moderately small	54	24	977	15
	Very small	52	23	340	5
	Total	223	100	6462	100
VIC	Large	1072	59	55 520	86
	Moderately small	342	19	6464	10
	Very small	391	22	2421	4
	Total	1805	100	64 405	100
WA	Large	470	54	23 523	85
	Moderately small	144	17	2656	10
	Very small	258	30	1494	5
	Total	872	100	27 673	100

As a preliminary exercise, schools were classified into different sizes according to PISA (2003, p. 53) classification rules: Large (MOS >= 25) and Small schools which were sub-divided into either Moderately Small (TCS/2 <= MOS < TCS) or Very Small (MOS < TCS/2) schools. **Table 3.5** shows the proportions of Large, Moderately Small and Very Small schools within each jurisdiction. It can be seen that there are many small schools in each jurisdiction. As such, it was important that an appropriate strategy was utilised to prevent an over-selection of small schools, which would have resulted in a sample size lower than the desired target sample size.

PISA (2003) guidelines were utilised for classifying and stratifying small schools, which involved deliberately under-sampling small schools and slightly over-sampling large schools. This ensured that small schools were represented in the sample while still achieving an adequate overall student sample size without substantially increasing the total number of schools sampled (see OECD 2003, pp. 53–57).

The MOS for a small school was set to the average ENR of all schools within the same explicit stratum and school size category. This strategy was adapted from the TIMSS (2003) approach to ensure that selection of very small schools would not result in excessively large sampling weights (see IEA 2003, pp. 119–120, section 5.4.1).

3.5.2 Very large schools

Selecting schools with a probability proportional to size (PPS) can result in a school being sampled more than once if its ENR is sufficiently large. This can occur when the school enrolment size is larger than the explicit stratum sampling interval. To overcome this, very large schools had their MOS set equal to the size of the sampling interval of the explicit stratum that the school belonged to (an option that was utilised in TIMSS 2003, p. 120, section 5.4.2).

3.6 Replacement schools

Replacement schools were included in the sample to help overcome problems in relation to school non-participation. For example, if the non-participation rate is high, then the target sample sizes will not be achieved. Further, if non-participating schools tend to be lower performing schools, then a bias in the estimated achievement levels will likely occur.

If a school did not participate for some reason, then a replacement school was selected for inclusion in the sample. Replacement schools were assigned as per PISA 2003 procedures (p. 60). That is, for a sampled school, the school immediately following it in the sampling frame was assigned as the first replacement school for it, and the school immediately preceding it was assigned as the second replacement school.

3.7 Class selection

One classroom containing Year 6 students was sampled per school. Classrooms generally had equal probabilities of selection. The overall procedure for class selection was as follows:

1 each class in a school was assigned a random number

2 the classes in a school were ordered by the assigned random numbers

3 the first class on each school's ordered list was chosen for the sample.

Small classes

Quite often schools had multilevel or remedial classes that contained small numbers of Year 6 students. If many of these small classes are selected, the total sample size will likely be less than the original target sample size, as the class size for these classes is much smaller than the average class size of 25 which was used as the basis for the estimation of the number of schools and classes to be selected.

To overcome this problem, a strategy was employed that built on both TIMSS (2003) and the procedures used for the National Assessment Program (literacy and numeracy trial 2006)[8]. Classes with fewer than 20 students were combined with another class at the same school. The resulting pseudo-class was considered a single classroom for sampling purposes.

Pseudo-classes were created from a maximum of two intact classrooms to minimise the administrative burden on schools and each pseudo-class comprised no more than 30 students in total. The formal procedure for creating pseudo-classes was:

(1) randomly order the school class list

(2) starting from the first class in the list, check to see if the class has fewer than 20 students (small-class)

(3) combine the small-class with the next class where the resulting sum is not larger than 30 students

(4) continue through the ordered school list until all classes have been checked/combined.

[8] See NAP WEBSITE MANUAL V02 22_02_06.pdf.

Using this method, the resulting sample size was close to, but slightly less than, the original proposed sample size (approx 97%). Because of the structure of school classes, it was possible a small class (fewer than 20 students) could potentially not be combined into a pseudo-class (e.g. because there was only one remedial class at the school and all other classes were standard size). In these cases, the second class in the list was taken, provided that:

(1) the second class was larger than the first class, and

(2) the second class had more than 20 students.

This procedure for handling small classes means that the resulting sample size will closely match the proposed sample size. In these cases, however, classes are selected with unequal probabilities, because the probability of selection depends on the number of classes, class sizes and the probability of forming pseudo-classes. The estimation of appropriate sampling weights to account for unequal probability of selection is covered in detail in Chapter 5, Computation of Sampling Weights.

3.8 The 2006 proposed sample

Table 3.6 outlines the number of schools to be sampled implementing the procedures outlined in previous sections. Further details on the characteristics of the schools actually sampled are included in Appendix G.

Table 3.6 Number of schools to be sampled

State/ Territory	Proposed target sample size for 2006	Number of schools by stratum					Total
		Very small	Moderately small	Large Catholic	Large govt	Large other	
ACT	1400	2	8	11	31	7	59
NSW	2100	7	9	14	54	8	92
NT	950	12	7	3	24	3	49
QLD	2100	8	8	12	57	8	93
SA	2100	9	16	12	48	10	95
TAS	1400	6	12	6	36	4	64
VIC	2100	6	11	16	52	6	91
WA	2100	10	11	12	53	8	94
Total	14 250	60	82	86	355	54	637

3.9 2006 National Assessment Program – Science Literacy sample results

Table 3.7 provides a breakdown of the sample according to jurisdiction. The target sample is the number of Year 6 students enrolled *at the time of testing* in the sampled schools. The achieved sample is the number of Year 6 students that participated (attempted the test).

Table 3.7 The National Assessment Program – Science Literacy target and achieved sample sizes by jurisdiction

State/ Territory	Number of students enrolled at the time of testing		Number of students who participated in the test	
	Students	Per cent	Students	Per cent
ACT	1346	9.5	1271	9.8
NSW	2212	15.6	2039	15.8
NT	867	6.1	740	5.7
QLD	2195	15.5	2016	15.6
SA	2002	14.1	1809	14.0
TAS	1330	9.4	1225	9.5
VIC	2020	14.3	1810	14.0
WA	2184	15.4	2001	15.5
Total	14 156	100.0	12 911	100.0

The numbers of non-participation students are provided in **Table 3.8**, broken down by jurisdiction and reason for non-participation.

Table 3.8 Student non-participation by jurisdiction

State/ Territory	Non inclusion code					Total
	Absent	Functional disability	Intellectual disability	Limited language proficiency	Student or parent refusal	
ACT	70	1	1	2	1	75
NSW	162	1	7	2	1	173
NT	112	0	3	10	2	127
QLD	155	1	10	8	5	179
SA	169	1	9	2	12	193
TAS	95	2	6	2	0	105
VIC	191	0	8	5	6	210
WA	164	1	8	10	0	183
Total	1118	7	52	41	27	1245

Additional technical specifications can be found in Appendices E and F.

Chapter 4
Test Administration Procedures and Data Preparation

4.1 Online registration of class/student lists

In 2006 BEMU commissioned an online software application from Curriculum Corporation called the Online Student Registration System (OSRS). School Contact Officers of schools selected for the sample were informed that they were to register their students online or for a few jurisdictions that this task had been done centrally. State and Territory Liaison Officers were briefed in providing support to principals to use the site. OSRS was designed to capture information that had previously been provided by students on the test book covers in 2003. Pre-registration meant that test books could be overprinted with individual student details, ensuring that every student received the correct test form and that student details were correct. It should be noted, however, that much data that schools were requested to provide on OSRS proved to be missing. Thus the data was incomplete when supplied for analysis preventing the inclusion of some demographic variables in the item response model (e.g. LBOTE).

4.2 Administering the tests to students

The final assessments were administered to the sampled students in October 2006. The participating schools were sent the following assessment materials: School Contact Officer's Manual; Test Administrator's Manual; and the assessment instruments; together with the appropriate practical materials for the particular task being undertaken.

The assessment instruments were administered to a sample consisting of 4.83% of the total Australian Year 6 student population. Tests were administered on the following dates:

- 18 October 2006 – Northern Territory, Queensland, Tasmania
- 25 October 2006 – Australian Capital Territory, New South Wales, South Australia, Victoria, Western Australia.

Students' regular class teachers administered the tests to minimise disruption to the normal class environment. Standardised administration procedures were developed and published in the Test Administrator's Manual. In all schools in which students were to complete the assessment, teachers and school administrators were provided with the Manual. Detailed instructions were also given in relation to the participation or exclusion of students with disabilities and students from non-English speaking backgrounds.

The teachers were able to review the manual before the assessment date and raise questions with the coordinators of the National Assessment Program – Science Literacy in their jurisdiction. A toll-free telephone number was provided and also an email address if teachers had any questions.

Teachers were required to complete a student participation form, confirming details about any student who may have not participated or had been excluded (see Appendix D).

A quality-monitoring program was established to gauge the extent to which class teachers followed the specified administration procedures. This involved trained monitors observing the administration of the Assessment in a random sample of classes in 30 of the 630 schools involved. The monitors reported conformity with the administration procedures.

4.3 Marking procedures

The multiple-choice items had only one correct answer. The open-ended items required students to construct their own responses. The open-ended items were further categorised into those that required a single-word or short-sentence response and those that required a more substantive response (referred to as 'extended-response' items). Some open-ended items had polytomous scores. That is, students could score either one or two marks depending on the quality or extent of their response.

Over half of the items were open-ended and required marking by trained markers. Some involved single answers or phrases that could be marked objectively.

Marking Guides were prepared by EAA and CC. The marking team included experienced teacher-markers employed by EAA. The markers participated in a four-hour training session conducted by a member of the test construction team. The session involved formal presentations by the trainers, followed by hands-on practice with sample student answer books. In addition, the markers undertook a further two hours of marking in which a pair of markers marked the same student answer books and moderators reconciled differences in

discussion with the markers. Markers were monitored constantly for reliability by having samples of their student answer books check-marked by group leaders. In cases where there were differences in scoring between markers and the group leaders, the scoring was reconciled jointly in consultation with the professional leader. This procedure, coupled with the intensive training at the beginning of the marking exercise, ensured that markers were applying the scoring criteria consistently.

4.4 Data entry procedures

The multiple-choice responses and teacher-marked scores were data processed. A validation of the data processing was performed that ensured accuracy in data capture.

Scanning software was used to capture images of all the student responses. These have been indexed and provided to BEMU for future reference.

Demographic information and information collected to determine student inclusion in the testing population was collected from participating schools using the Student Participation Form that had two parts: Part A was designed to collect information about the school (including information about the number of students enrolled in Year 6 and the number of classes in Year 6); and Part B collected relevant information about individual students.

4.4.1 Data coding rules

Data coding rules for collecting student inclusion information in the Student Participation Form are explained in full on pages 9 and 10 of the Test Administrator's Manual. **Table 4.1** contains codes that were used and their explanation.

Table 4.1 Codes used in the Student Participation Form

Special education needs codes
0 = No special education needs
1 = Functional disability
2 = Intellectual disability
3 = Limited test language proficiency
Non-inclusion codes
10 = Absent
11 = Not included; functional disability
12 = Not included; intellectual disability
13 = Not included; limited test language proficiency
14 = Student or parent refusal
Indigenous codes
1 = Aboriginal but not Torres Strait Islander origin
2 = Torres Strait Islander but not Aboriginal origin
3 = Both Aboriginal and Torres Strait Islander origin
4 = Neither Aboriginal nor Torres Strait Islander origin
9 = Not stated/unknown

Chapter 5
Computation of Sampling Weights

The sampling weights calculated for the National Assessment Program – Science Literacy were based on procedures detailed in TIMSS (IEA 2004), except for the computation of some class weights. The procedures outlined in TIMSS are designed for several different sampling scenarios. Only the procedures relevant to the National Assessment Program – Science Literacy context are presented here.

5.1 School weight

5.1.1 School base weight

School level base weight for school i

$$BW_{sc}^{i} = \frac{M}{n.m_i} \qquad (2)$$

where n was the number of sampled schools and m_i was the measure of size assigned to the i^{th} school, and

$$M = \sum_{i=1}^{N} m_i \qquad (3)$$

where N was the total number of schools in the explicit stratum.

For small school strata, schools were assigned equal MOS values. Small school sampling weights, using the above equations, can be given by:

$$BW_{sc}^{i} = \frac{N \cdot m_i}{n \cdot m_i} \qquad (4)$$

This can be simplified to:

$$BW_{sc}^{i} = \frac{N}{n} \qquad (5)$$

5.1.2 School non-participation adjustment

In total, 636 schools were sampled of which there were 15 schools that did not participate in the testing (and could not be replaced). Two schools were found to be ineligible in that there were no Year 6 students enrolled at the school at the time of testing. The remaining 13 schools were either exempted from testing or did not participate for some other reason.

A school-level non-response adjustment was calculated separately for each explicit stratum to account for schools that were sampled but did not participate. Such an adjustment means that the final school weights will be representative of the whole population of Year 6 students rather than the population directly represented by the participating schools.

Specifically, the non-response adjustment was calculated as:

$$A_{sc} = \frac{n_s + n_{r1} + n_{r2} + n_{nr}}{n_s + n_{r1} + n_{r2}} \qquad (6)$$

where:

- n_s was the number of originally sampled schools that participated
- n_{r1} and n_{r2} was the number of first and second replacement schools, respectively, that participated, and
- n_{nr} the number of schools that did not participate

Note that the two ineligible schools were not included in the calculation of this adjustment.[9]

5.1.3 Final school weight

The final school weight was then the product of the school base weight and non-participation adjustment:

$$FW_{sc}^{i} = A_{sc} \cdot BW_{sc}^{i} \qquad (7)$$

[9] See PISA 2003 Technical Report p. 111, TIMSS 2003 Sampling Weights and Participation Rates p. 202.

5.2 Class weight

Typically, when a class is selected at random, the probability of selection for the class is 1/n, where n is the total number of eligible classes in that school. Consequently, the class weight is n.

However, in the National Assessment Program – Science Literacy, for some schools the selection of classes was not carried out with all classes having equal probability of selection. For example, if there are two classes with size 12 and 20 respectively, the class with 20 students will be selected. This is so that the total number of selected students will not fall below the target size. It should be noted that, while an average class size of 25 students is assumed, a considerable number of classes have around 13–15 students.

The following provides two examples illustrating the probability of selection of a class in a school where there are some small classes.

Example 1

Consider three classes with class sizes as given below:

Table 5.1 Probability of selection of three classes

Class	Class size	Selected	Probability of selection
1	12	no	0
2	25	yes	0.5
3	27	no	0.5

Given the above three classes, no matter how the order of the classes is randomised in the list, the probability of class 1 being selected is zero. The selected class (class 2 or class 3) has a probability of 0.5 (1-in-2) of being selected, and not the usual 1-in-3 chance of being selected.

Example 2

Consider three classes with class sizes as given below:

Table 5.2 Class size of three classes

Class	Class size
1	10
2	10
3	10

Combine into pseudo-classes:

Table 5.3 Formation of a pseudo-class from classes listed in Table 5.2

Pseudo-class	Class size	Selected
1	20	yes
2	10	no

For the original three classes, the probability that a class is not combined with another to form a pseudo-class is 1/3. Since the combined pseudo-class will always be selected (as the single class has fewer than 20 students), the probability of any class being selected is 2/3, and not 1/2 (as would be the case if one out of two pseudo-classes is selected at random).

Probability of selection:

Table 5.4 Probability of selection of classes listed in Table 5.2

Class	Probability of selection
1	2/3
2	2/3
3	2/3

Consequently, if a school has small classes (fewer than 20 students), then the computation of class weights depends on the number of classes and class size. There is no simple formula that can be applied to all cases. Therefore, the probability of selection for a class was computed empirically. This was done by replicating the classroom sampling procedures 1000 times. The class weight was then the inverse of the empirical probability of selection.

Empirical class weights were used only when the class selection probabilities were unequal, otherwise class weights were simply equal to the number of classes at the school (n). More specifically, empirical class weights were used when:

(1) it was possible to create a pseudo-class at the school, or

(2) the school had both a small class (fewer than 20 students) and a large class (20 or more students).

5.2.1 Class weight when classes were selected with equal probability

When classes were selected with equal probability, the base classroom weight is given by:

$$BW_{cl1}^{i} = \frac{C^{i}}{c^{i}} \qquad (8)$$

where C^i is the total number of classes for the i^{th} school and c^i is the total number of sampled classrooms. For the National Assessment Program – Science Literacy only one class was selected per school, so the base class weight is simply equal to the number of eligible Year 6 classes at the school:

$$BW_{cl1}^{i} = C^{i} \qquad (9)$$

5.2.2 Class weight when classes were selected with unequal probability

5.2.2.1 Empirical classroom weight

The base empirical classroom weight when a single natural (non-pseudo) class was selected is given by:

$$BW_{cl2}^{i} = \frac{R}{\sum_{j=1}^{R} d_{ij}} \qquad (10)$$

where R is the number of times the class selection procedure was replicated and d is an indicator equal to one (1) if the sampled class for school i is sampled for replication j otherwise d is equal to zero (0).

When a pseudo-class is selected, it is possible for the (natural) classes constituting the pseudo-class to have different probabilities of being selected. However, as we do not have readily available information on the natural class which a student is from, a weighted average of classroom weights is computed for all students in the selected pseudo-class, as illustrated below.

When a pseudo-class was selected, the base empirical class weight was set equal to the weighted mean of the base class weight for the two natural classes that were originally used to create the pseudo-class:

$$BW_{cl3}^{i} = \frac{n_1 b_1 + n_2 b_2}{n_1 + n_2} \qquad (11)$$

where b_1 and b_2 are equal to the base empirical class weight (BW^{i}_{cl3}) for the first and second natural classes of the selected pseudo-class at school i respectively. In addition, n_1 and n_2 are the class sizes for the first and second natural classes, respectively, of the selected pseudo-class.

5.2.2.2 Empirical weight adjustment

The procedure for selecting a class for participation, in certain situations, resulted in a class having zero probability of selection for inclusion in the study. Consider example 1 illustrated previously. In example 1 there are 64 eligible Year 6 students at the school in three classes of sizes 12, 25 and 27 students. However, the class with 12 students has zero probability of selection as this class could not be combined with another to form a pseudo-class and there was always a larger class that would be selected instead of this class. This means that either the class of 25 or 27 students would be sampled with a probability of 0.5, resulting in a class weight of 2 for this school. Overall the school is estimated to have either 50 or 54 students which is fewer than the 64 that actually are at the school. To overcome this bias an adjustment

was made to account for students that had zero probability of selection. The zero probability adjustment is:

$$A_{cl}^{i} = \frac{n_{sc}^{i}}{n_{sc}^{i} - n_{cl0}^{i}} \qquad (12)$$

where n^{i}_{sc} is the number of students at school i and n^{i}_{cl0} is the number of students at school i who had zero probability of inclusion in the study due to the class selection procedure. n^{i}_{cl0} by definition is the number of students in a single small class at a school where that small class could not be combined with another class to form a pseudo-class and, in addition, there was also a large class at the same school that could be selected for participation instead of the small class.

5.2.3 Final class weight

The final class weight was then a product of the base class weight and the zero probability of selection adjustment:

$$FW_{cl}^{i} = A_{cl}^{i} \cdot BW_{cl\Delta}^{i} \qquad (13)$$

where $\triangle$ equals: 1 when a class was selected with equal probability; 2 when a natural class was selected without equal probability; and 3 when a pseudo-class was selected without equal probability. Note that A^{i}_{cl} is always equal to 1 whenever $\triangle$ equals 1. That is, the final class weight is equal to the base class weight when classes were selected with equal probabilities.

5.2.4 Student weight

Each student in the sampled class was certain of selection at the student level. The student base weight was therefore equal to 1 for all students.

$$BW_{st}^{i} = 1.0 \qquad (14)$$

A student non-participation adjustment was calculated for any school that had at least one student that was eligible to do the test but did not participate for some reason. This was given by:

$$A_{st}^{i} = \frac{s_{rs}^{i} + s_{nr}^{i}}{s_{rs}^{i}} \qquad (15)$$

where s^{i}_{rs} was the number of eligible students that participated, and s^{i}_{rs} was the number of eligible students that did not participate[10], at the i^{th} school.

[10] These are the absent and refusal students and does not include exclusions such as functionally disabled.

The final student weight is then equal to the product of the student base weight and non-participation adjustment.

$$FW_{st}^{i} = A_{st}^{i} \cdot BW_{st}^{i} \tag{16}$$

This simplifies to

$$FW_{st}^{i} = A_{st}^{i} \tag{17}$$

That is, the student final weight is equal to the student non-participation adjustment.

5.2.5 Final weight

In summary, the final weight is the product of the final school, class and student weights:

$$W^{i} = FW_{sc}^{i} \cdot FW_{cl}^{i} \cdot FW_{st}^{i} \tag{18}$$

Chapter 6
Item Analysis of the Final Test

6.1 Item analyses

This document presents the item analyses of the National Assessment Program – Science Literacy 2006 main survey data. Overall the items performed very well, with the RUMM test-of-fit indicating an 'Excellent' fit.

6.1.1 Sample size

In all, 12 920 students participated in at least one of the two National Assessment Program – Science Literacy tests: the paper-and-pencil test and the practical test.

Table 6.1 shows the number of students by State/Territory.

Table 6.1 Number of students by State/Territory

State	No. of students
ACT	1271
NSW	2039
NT	741
QLD	2017
SA	1811
TAS	1225
VIC	1811
WA	2005
Total	12 920

6.1.2 Number of students by booklet

Seven test booklets with link items were rotated in each class (see Section 6.2 for test design). Each student completed only one test booklet. **Table 6.2** shows the number of students that completed each test booklet. It can be seen that the test rotation scheme worked well, as the number of students per booklet is approximately equal across the seven booklets.

Table 6.2 Number of students by test booklet

Booklet	No. of students
1	1849
2	1842
3	1861
4	1850
5	1832
6	1827
7	1859
Total	12 920

As each item appears in three test booklets, the number of students taking each item is around 5500.

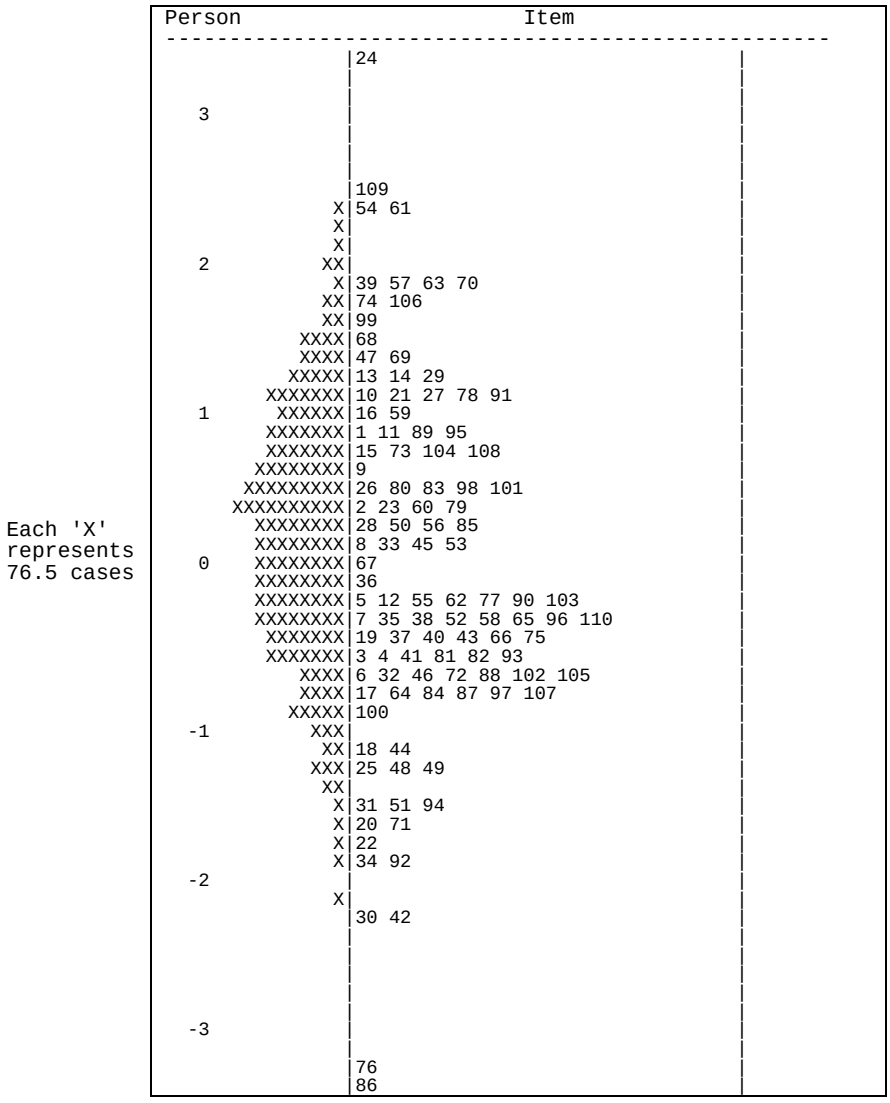
6.1.3 Initial item analysis

The first item analysis carried out was on all data records. No sampling weights were used. This analysis aimed to detect any items that did not function well. In this analysis, all trailing missing item responses were treated as not-administered, except for the first item following the last non-missing item. Embedded missing responses were treated as incorrect. A complete list of items and their codes is attached at Section 6.3.

6.1.3.1 Item–person map

Figure 6.1 shows an item–person map from this analysis.

Figure 6.1 Item–person map



The vertical scale in **Figure 6.1** shows increasing proficiency, with student ability distribution shown in the left panel (indicated by 'X'). The items are placed in the right panel (indicated by item numbers) in item difficulty order, where items at the top are most difficult.

Figure 6.1 shows that the items cover a wide range of difficulty levels. The average item difficulty is zero logit, while the average ability is 0.22 logit, showing that the match between item difficulties and person abilities is quite good overall.

6.1.3.2 Summary item statistics

Table 6.3 shows summary item statistics for each of the 110 items.

Table 6.3 Summary item statistics

Item label	No. of students	Percentage correct	Discrimination index	Fit mean square	Comments
item:1 (ID0B008)	5385	37.12	0.47	0.94	
item:2 (ID0B009)	5356	46.30	0.45	0.96	
item:3 (ID0B011)	5275	67.20	0.48	0.92	
item:4 (ID0B012)	5249	65.82	0.41	0.98	
item:5 (ID0B013)	5192	59.01	0.28	1.12	
item:6 (ID0B014)	5401	69.15	0.42	0.97	
item:7 (ID0B015)	5365	61.08	0.37	1.03	
item:8 (ID0B016)	5347	50.35	0.24	1.15	Checked by test developers. Note DIF re locale
item:9 (ID0B019)	5453	42.05	0.45	0.97	
item:10 (ID0B020)	5432	31.68	0.35	1.02	
item:11 (ID0B021)	5426	35.42	0.31	1.05	
item:12 (ID0B022)	5416	58.47	0.45	0.97	
item:13 (ID0B023)	5411	29.81	0.26	1.08	
item:14 (ID0B029)	5087	29.03	0.34	1.02	
item:15 (ID0B030)	4971	40.56	0.40	0.99	
item:16 (ID0B031)	4852	35.90	0.40	0.99	
item:17 (ID0B040)	5461	71.34	0.38	1.00	
item:18 (ID0B041)	5409	76.41	0.28	1.08	
item:19 (ID0B044)	5397	63.79	0.35	1.06	
item:20 (ID0B046)	5349	84.39	0.42	0.92	
item:21 (ID0B047)	5322	32.68	0.40	0.98	
item:22 (ID0B048)	5301	84.78	0.40	0.93	
item:23 (ID0B049)	5291	46.66	0.34	1.06	
item:24 (ID0B054)	5408	5.94	0.27	0.97	
item:25 (ID0B055)	5440	78.99	0.43	0.94	
item:26 (ID0B056)	5428	44.99	0.52	0.91	
item:27 (ID0B057)	5412	32.30	0.22	1.14	Checked by test developers. Significant DIF in ACT (v. low disc. in ACT)
item:28 (ID0B067)	5339	48.29	0.50	0.93	
item:29 (ID0B068)	5431	28.56	0.45	0.93	
item:30 (ID0B069)	5445	89.70	0.46	0.87	
item:31 (ID0B071)	5438	81.34	0.40	0.96	
item:32 (ID0B072)	5424	68.90	0.38	1.01	
item:33 (ID0B074)	5467	52.11	0.45	0.98	
item:34 (ID0B076)	5470	86.51	0.41	0.93	

Item label	No. of students	Percentage correct	Discrimination index	Fit mean square	Comments
item:35 (ID0B077)	5462	60.75	0.44	0.98	
item:36 (ID0B080)	5395	56.53	0.24	1.15	Checked by test developers. V. consistent disc. across locales
item:37 (ID0B084)	5420	63.99	0.31	1.09	
item:38 (ID0B085)	5403	62.15	0.41	0.99	
item:39 (ID0B086)	5392	20.40	0.26	1.06	
item:40 (ID0B087)	5363	63.58	0.50	0.91	
item:41 (ID0B088)	5356	67.14	0.53	0.87	Checked by test developers. V. high disc. in NT
item:42 (ID0B093)	5436	90.12	0.31	0.97	
item:43 (ID0B096)	5420	64.67	0.49	0.93	
item:44 (ID0B097)	5423	77.60	0.39	0.97	
item:45 (ID0B098)	5409	50.31	0.42	0.99	
item:46 (ID0B100)	5462	68.00	0.43	0.98	
item:47 (ID0B103)	5454	27.65	0.38	1.00	
item:48 (ID0B106)	5351	78.66	0.41	0.96	
item:49 (ID0B109)	5384	79.49	0.43	0.95	
item:50 (ID0B110)	5366	48.01	0.32	1.08	
item:51 (ID0B111)	5358	82.59	0.41	0.95	
item:52 (ID0B113)	5472	60.40	0.42	1.00	
item:53 (ID0B116)	5460	51.63	0.42	0.99	
item:54 (ID0B117)	5434	12.86	0.26	1.02	
item:55 (ID0B121)	5438	59.07	0.46	0.95	
item:56 (ID0B122)	5437	50.01	0.52	0.90	
item:57 (ID0B123)	5433	19.01	0.40	0.93	
item:58 (ID0B135)	5456	62.52	0.41	1.01	
item:59 (ID0B138)	5442	34.03	0.31	1.07	
item:60 (ID0B145)	5391	46.93	0.43	0.98	
item:61 (ID0B146)	5369	13.22	0.33	0.96	
item:62 (ID0B147)	5335	59.49	0.49	0.94	
item:63 (ID0B148)	5278	19.42	0.32	1.01	
item:64 (ID0B149)	5419	70.60	0.46	0.95	
item:65 (ID0B150)	5396	60.82	0.49	0.93	
item:66 (ID0B152)	5379	64.55	0.61	0.82	Checked by test developers. Uncommon item type.
item:67 (ID0B160)	5324	54.53	0.48	0.95	
item:68 (ID0B161)	5301	26.41	0.37	1.00	

Item label	No. of students	Percentage correct	Discrimination index	Fit mean square	Comments
item:69 (ID0B162)	5266	27.17	0.34	1.02	
item:70 (ID0B163)	5242	20.07	0.32	1.02	
item:71 (ID0B165)	5497	84.34	0.40	0.94	
item:72 (ID0B167)	5482	69.61	0.22	1.15	Checked by test developers. Note DIF re locale
item:73 (ID0B168)	5475	37.92	0.32	1.06	
item:74 (ID0B170)	5454	21.40	0.33	1.02	
item:75 (ID0B173)	5449	65.72	0.33	1.05	
item:76 (ID0B174)	5423	95.76	0.26	0.96	
item:77 (ID0B177)	5309	57.69	0.45	1.05	
item:78 (ID0B178)	5245	32.37	0.36	1.01	
item:79 (ID0B179)	5474	45.82	0.33	1.06	
item:80 (ID0B180)	5461	44.52	0.32	1.07	
item:81 (ID0B181)	5458	66.98	0.39	1.01	
item:82 (ID0B182)	5345	66.36	0.23	1.14	Checked by test developers. Contentious content – suggest delete item
item:83 (ID0B184)	5420	45.42	0.47	1.05	
item:84 (ID0B185)	5384	71.60	0.26	1.10	
item:85 (ID0B186)	5367	49.06	0.29	1.09	
item:86 (ID0B190)	5490	96.14	0.21	0.98	The discrimination is low because the item is very easy. The fit index is fine too.
item:87 (ID0B192)	5482	71.40	0.41	0.99	
item:88 (ID0B193)	5474	68.09	0.36	1.03	
item:89 (ID0B204)	5367	37.02	0.52	0.89	Checked by test developers.
item:90 (ID0B207)	5340	59.06	0.40	1.02	
item:91 (ID0B209)	5316	31.75	0.32	1.06	
item:92 (A_Q1)	6700	86.16	0.25	1.04	The low discrimination is probably related to the high facility. The fit is fine.
item:93 (A_Q3)	6701	67.62	0.31	1.08	
item:94 (A_Q4)	6702	82.18	0.39	0.96	
item:95 (A_Q6)	6701	36.05	0.32	1.06	
item:96 (A_Q7)	6701	62.54	0.49	0.92	
item:97 (A_Q9)	6700	70.87	0.50	0.91	
item:98 (A_Q10)	6700	45.43	0.28	1.11	
item:99 (A_Q12)	6701	23.64	0.36	0.99	
item:100 (A_Q13)	6700	72.61	0.43	0.96	

Item label	No. of students	Percentage correct	Discrimination index	Fit mean square	Comments
item:101 (A_Q14)	6700	44.37	0.47	0.95	
item:102 (C_Q2)	6028	68.17	0.23	1.15	Checked by test developers.
item:103 (C_Q3)	6028	59.09	0.37	1.04	
item:104 (C_Q4)	6027	39.27	0.42	0.99	
item:105 (C_Q5)	6027	67.46	0.42	0.98	
item:106 (C_Q6)	6027	21.39	0.39	0.96	
item:107 (C_Q7)	6027	71.20	0.34	1.05	
item:108 (C_Q9)	6027	38.33	0.36	1.04	
item:109 (C_Q10)	6027	12.69	0.32	0.97	
item:110 (C_Q12)	6034	60.54	0.47	0.95	

Items falling outside parameters of discrimination 0.25–0.5 and fit 0.9–1.1 have been checked by test developers as indicated on this **Table 6.3**. The overall recommendation is that all but one item (Item 82, IDOB182) are fit to be retained. The item recommended for deletion contained content referring to Pluto as a planet; this categorisation was changed by the international scientific community after the tests went to print.

Item Characteristic Curves (ICCs) from RUMM can be found in the 'ICCs' worksheet of the file at Section 6.5.

6.1.3.3 Test reliability

Person separation reliability for the National Assessment Program – Science Literacy 2006 tests is 0.87, which is quite satisfactory[11].

6.1.4 Booklet effect

The so-called 'booklet effect' refers to the differences in booklet difficulties after equating of the booklets has been carried out. That is, students may be advantaged or disadvantaged by taking a particular test booklet, even after booklets have been equated. An estimation of booklet adjustments has been carried out through a ConQuest analysis with model statement booklet + item + item*step, and **Table 6.4** shows the booklet estimates.

[11] In comparison, the reported reliability for PISA 2003 mathematics is 0.85, and 0.89 for TIMSS 2003 Grade 8 mathematics.

Table 6.4 Booklet difficulty parameters

Booklet Number	Booklet parameter (logit)	Error
1	−0.006	0.006
2	−0.042	0.006
3	0.054	0.006
4	−0.020	0.006
5	0.048	0.006
6	0.020	0.006
7	−0.053	0.014

The booklet parameters shown in **Table 6.4** are very close to zero, indicating that booklet effect is not a serious issue for this assessment. However, in estimating student proficiency levels, booklet effect will be taken into account. Booklet effect was set as one of the model parameters in estimating student parameters in ConQuest.

6.1.5 Item statistics by States/Territories

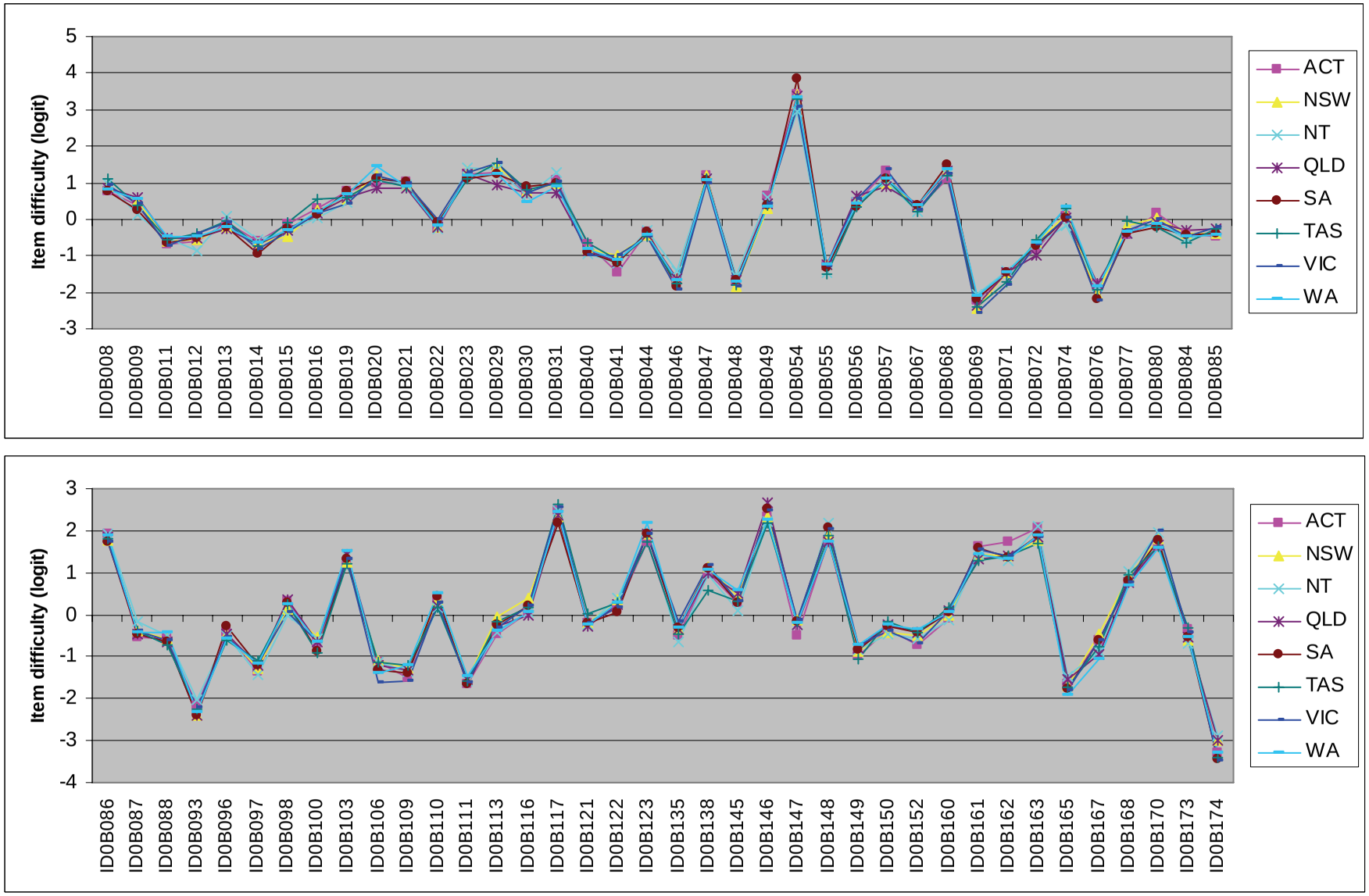
While the items worked quite well in general for the overall sample, it is important to check if the items performed well within each State/Territory, and whether the item difficulties are similar across States/Territories. In the following analysis, item analysis was carried out for each State/Territory separately. In this way, it is possible to check (1) whether there are problematic items at the State/Territory level; and (2) whether there is differential item functioning across States/Territories (i.e. some States/Territories may find particular items easier or more difficult).

6.1.5.1 Comparison of item difficulty parameters across States/Territories

Figure 6.2 shows a comparison of item difficulties calibrated for each State/Territory separately. For each State/Territory, the average item difficulty was set to zero, so that each item difficulty shows the deviation from the average item difficulty within that State/Territory. In this way, the item difficulties across different States/Territories can be compared, as the overall ability level of students for each State/Territory is controlled for. If an item has very different difficulty values across States/Territories, then there is evidence of differential item functioning.

Figure 6.2 shows that the calibrated item difficulties are very similar across States/Territories. That is, there is little evidence of differential item functioning. In fact, the similarities of item difficulties across States/Territories are quite remarkable.

Figure 6.2 Comparison of item difficulty parameters across States/Territories



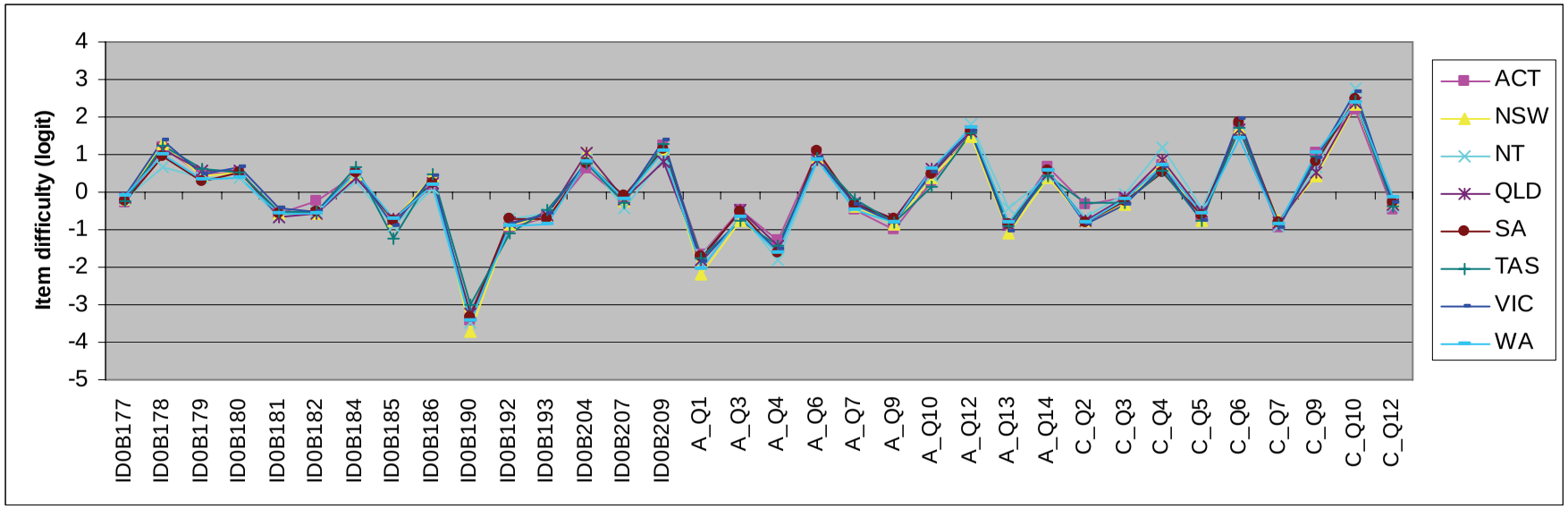
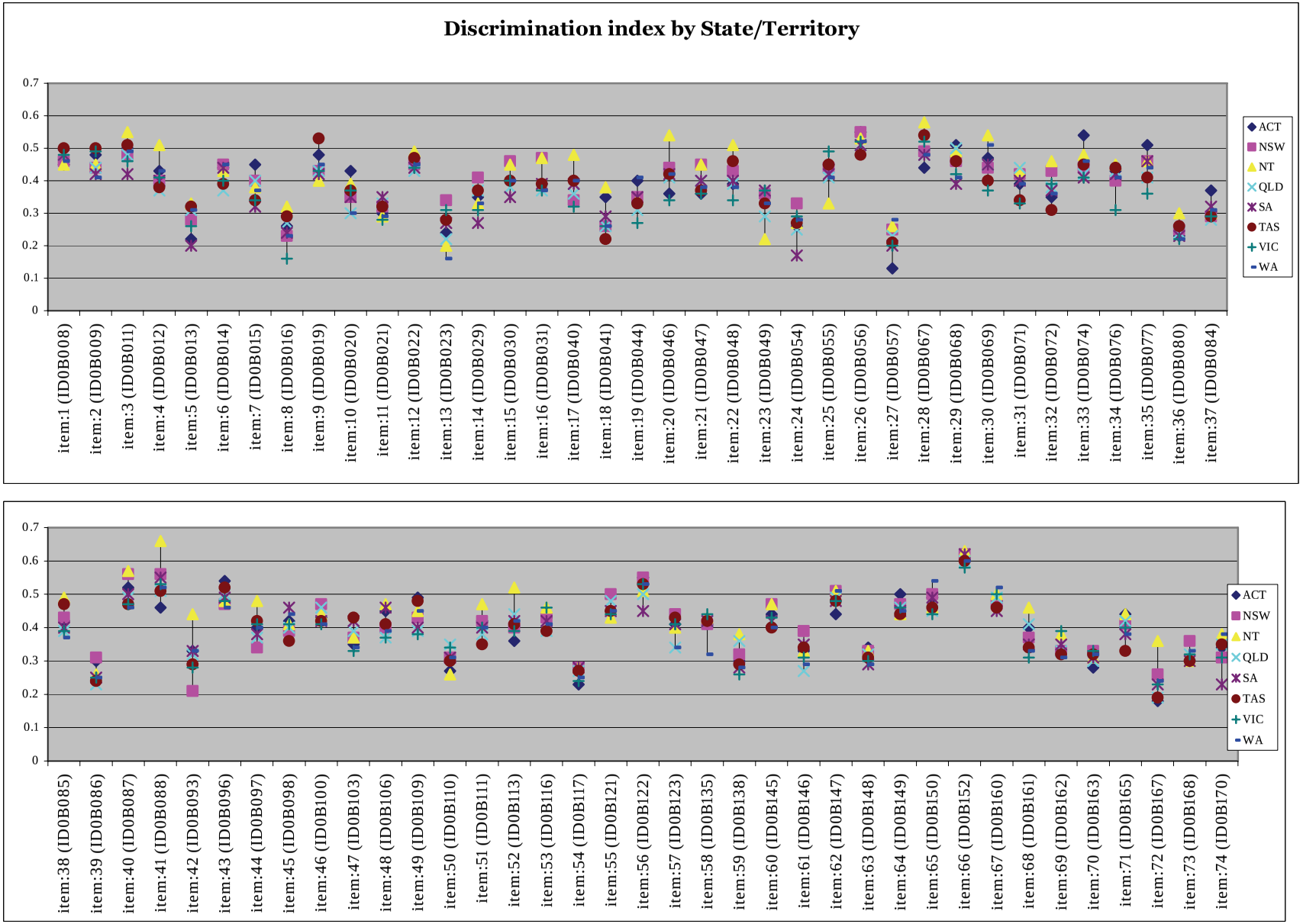
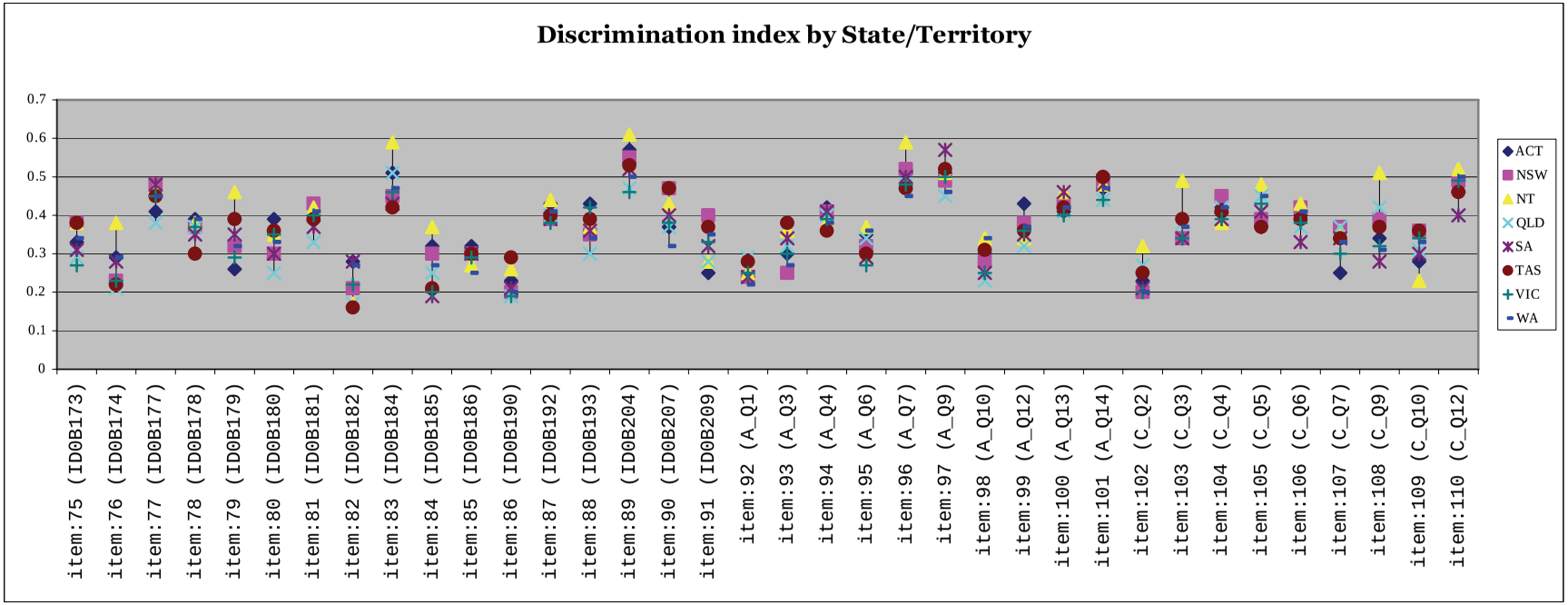

Item difficulty (logit)
4
3
2
1
0
-1
-2
-3
-4
-5
ID0B177
ID0B178
ID0B179
ID0B180
ID0B181
ID0B182
ID0B184
ID0B185
ID0B186
ID0B190
ID0B192
ID0B193
ID0B204
ID0B207
ID0B209
A_Q1
A_Q3
A_Q4
A_Q6
A_Q7
A_Q9
A_Q10
A_Q12
A_Q13
A_Q14
C_Q2
C_Q3
C_Q4
C_Q5
C_Q6
C_Q7
C_Q9
C_Q10
C_Q12
ACT
NSW
NT
QLD
SA
TAS
VIC
WA

Figure 6.3 Discrimination index by State/Territory




Discrimination index by State/Territory
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
ACT
NSW
NT
QLD
SA
TAS
VIC
WA
item:75 (ID0B173)
item:76 (ID0B174)
item:77 (ID0B177)
item:78 (ID0B178)
item:79 (ID0B179)
item:80 (ID0B180)
item:81 (ID0B181)
item:82 (ID0B182)
item:83 (ID0B184)
item:84 (ID0B185)
item:85 (ID0B186)
item:86 (ID0B190)
item:87 (ID0B192)
item:88 (ID0B193)
item:89 (ID0B204)
item:90 (ID0B207)
item:91 (ID0B209)
item:92 (A_Q1)
item:93 (A_Q3)
item:94 (A_Q4)
item:95 (A_Q6)
item:96 (A_Q7)
item:97 (A_Q9)
item:98 (A_Q10)
item:99 (A_Q12)
item:100 (A_Q13)
item:101 (A_Q14)
item:102 (C_Q2)
item:103 (C_Q3)
item:104 (C_Q4)
item:105 (C_Q5)
item:106 (C_Q6)
item:107 (C_Q7)
item:108 (C_Q9)
item:109 (C_Q10)
item:110 (C_Q12)

6.1.5.2 Comparison of discrimination indices across States/Territories

Figure 6.3 shows a comparison of discrimination indices across States/Territories. For most items, the discrimination indices are similar across States/Territories. For a few items, the discrimination index falls below 0.2 for some States/Territories. In particular, the lowest discrimination index is 0.13 for item 27 (ID0B057) for ACT. For this item, the detailed item statistics are shown in **Figure 6.4**. It can be seen from **Figure 6.4** that both options 1 and 2 of this item attracted equally able students in ACT.

Figure 6.4 Item analysis for item ID0B057 for ACT

ACT: item: 27 (ID0B057)

Cases for this item	540	Discrimination	0.13
Item threshold(s):	1.34	Weighted MNSQ	1.20
Item delta(s):	1.34		

Label	Score	Count	% of tot	Pt Bis	t (p)	PV1Avg:1	PV1 SD:1
1	0.00	231	42.78	0.14	3.26(.001)	0.48	0.85
2	1.00	161	29.81	0.13	3.14(.002)	0.55	0.88
3	0.00	110	20.37	−0.26	−6.13(.000)	−0.12	0.86
4	0.00	22	4.07	−0.06	−1.32(.187)	0.18	1.12
9	0.00	16	2.96	−0.10	−2.22(.027)	−0.12	0.99

For other items, please refer to attached item analysis files (Section 6.4).

6.1.5.3 Comparison of State/Territory locations in RUMM

Analysis using RUMM software shows that for most items the locations are similar across States/Territories. A few items fall outside of the confidence interval (comparing the State/Territory location to the location on a combined analysis).

For further details please refer to Section 6.5.

6.1.6 Gender groups

To examine differential item functioning between gender groups, the item response data were analysed separately for girls and boys.

Table 6.5 shows item parameters calibrated separated for gender groups, arranged in order of the difference between the item difficulty parameters. The left side of the table shows items where girls performed better, and the right side of the table shows items where boys performed better. For most items, the difference in item difficulty parameters is small. If one takes 0.5 logit as a cut-off value for identifying large gender difference, then only three items fall in this category: girls performed better on item 30 (ID0B069) and item 76 (ID0B174), and boys performed better on item 72 (ID0B167).

Table 6.5 Item difficulty parameters for gender groups

Girls performed better					Boys performed better				
Item	**Code**	**Girls**	**Boys**	**Diff**	**Item**	**Code**	**Girls**	**Boys**	**Diff**
30	ID0B069	−2.653	−2.016	−0.637	72	ID0B167	−0.483	−1.001	0.518
76	ID0B174	−3.541	−2.99	−0.551	37	ID0B084	−0.211	−0.684	0.47
92	A_Q1	−2.127	−1.641	−0.486	69	ID0B162	1.626	1.213	0.413
93	A_Q3	−0.85	−0.39	−0.46	56	ID0B122	0.441	0.033	0.40
31	ID0B071	−1.73	−1.327	−0.403	50	ID0B110	0.542	0.137	0.40
100	A_Q13	−1.086	−0.7	−0.386	38	ID0B085	−0.151	−0.555	0.40
87	ID0B192	−1.045	−0.668	−0.377	55	ID0B121	−0.018	−0.397	0.37
59	ID0B138	0.87	1.179	−0.309	74	ID0B170	1.941	1.583	0.35
106	C_Q6	1.581	1.869	−0.288	4	ID0B012	−0.35	−0.695	0.34
99	A_Q12	1.469	1.748	−0.279	41	ID0B088	−0.435	−0.773	0.33
97	A_Q9	−0.915	−0.65	−0.265	81	ID0B181	−0.413	−0.723	0.31
48	ID0B106	−1.413	−1.149	−0.264	73	ID0B168	0.979	0.669	0.31
103	C_Q3	−0.36	−0.099	−0.261	52	ID0B113	−0.133	−0.428	0.29
105	C_Q5	−0.788	−0.529	−0.259	57	ID0B123	2.072	1.783	0.28
32	ID0B072	−0.867	−0.609	−0.258	14	ID0B029	1.444	1.164	0.28
39	ID0B086	1.713	1.945	−0.232	6	ID0B014	−0.578	−0.851	0.27
44	ID0B097	−1.353	−1.122	−0.231	88	ID0B193	−0.538	−0.805	0.26
104	C_Q4	0.614	0.834	−0.22	22	ID0B048	−1.62	−1.887	0.26
96	A_Q7	−0.455	−0.247	−0.208	16	ID0B031	1.076	0.83	0.24
34	ID0B076	−2.064	−1.857	−0.207	64	ID0B149	−0.699	−0.945	0.24
35	ID0B077	−0.402	−0.208	−0.194	53	ID0B116	0.271	0.029	0.24
108	C_Q9	0.674	0.866	−0.192	66	ID0B152	−0.38	−0.613	0.23
68	ID0B161	1.365	1.556	−0.191	18	ID0B041	−1.026	−1.239	0.213
102	C_Q2	−0.786	−0.597	−0.189	11	ID0B021	1.033	0.837	0.196
17	ID0B040	−0.924	−0.739	−0.185	75	ID0B173	−0.412	−0.585	0.173
5	ID0B013	−0.254	−0.078	−0.176	79	ID0B179	0.527	0.373	0.154
33	ID0B074	0.026	0.198	−0.172	10	ID0B020	1.207	1.055	0.152
47	ID0B103	1.267	1.438	−0.171	43	ID0B096	−0.38	−0.53	0.15
70	ID0B163	1.783	1.95	−0.167	15	ID0B030	0.783	0.645	0.138
86	ID0B190	−3.478	−3.312	−0.166	21	ID0B047	1.169	1.032	0.137
84	ID0B185	−0.889	−0.724	−0.165	9	ID0B019	0.685	0.551	0.134
94	A_Q4	−1.611	−1.448	−0.163	80	ID0B180	0.586	0.454	0.132
91	ID0B209	1.043	1.204	−0.161	83	ID0B184	0.553	0.424	0.129
101	A_Q14	0.448	0.606	−0.158	23	ID0B049	0.481	0.356	0.125
95	A_Q6	0.855	0.994	−0.139	25	ID0B055	−1.248	−1.366	0.118
46	ID0B100	−0.755	−0.622	−0.133	110	C_Q12	−0.25	−0.357	0.107
58	ID0B135	−0.399	−0.314	−0.085	40	ID0B087	−0.369	−0.469	0.1
3	ID0B011	−0.627	−0.547	−0.08	61	ID0B146	2.439	2.34	0.09
1	ID0B008	0.835	0.904	−0.069	26	ID0B056	0.524	0.427	0.09
98	A_Q10	0.439	0.507	−0.068	24	ID0B054	3.41	3.314	0.09
60	ID0B145	0.345	0.411	−0.066	45	ID0B098	0.26	0.171	0.08
67	ID0B160	0.008	0.074	−0.066	109	C_Q10	2.464	2.378	0.08
65	ID0B150	−0.35	−0.293	−0.057	13	ID0B023	1.278	1.193	0.08
82	ID0B182	−0.552	−0.499	−0.053	19	ID0B044	−0.377	−0.46	0.08
42	ID0B093	−2.318	−2.265	−0.053	8	ID0B016	0.254	0.179	0.07
62	ID0B147	−0.243	−0.197	−0.046	7	ID0B015	−0.268	−0.317	0.04

29	ID0B068	1.28	1.322	−0.042	36	ID0B080	−0.048	−0.077	0.02
51	ID0B111	−1.593	−1.552	−0.041	2	ID0B009	0.435	0.417	0.01
20	ID0B046	−1.734	−1.696	−0.038	49	ID0B109	−1.334	−1.345	0.011
63	ID0B148	1.867	1.905	−0.038	107	C_Q7	−0.847	−0.851	0.00
28	ID0B067	0.306	0.344	−0.038	77	ID0B177	−0.171	−0.175	0.00
54	ID0B117	2.396	2.428	−0.032	27	ID0B057	1.102	1.1	0.00
78	ID0B178	1.108	1.134	−0.026	12	ID0B022	−0.163	−0.164	0.00
90	ID0B207	−0.229	−0.204	−0.025					
89	ID0B204	0.842	0.864	−0.022					
71	ID0B165	−1.719	−1.698	−0.021					
85	ID0B186	0.293	0.313	−0.02					

6.1.7 Impact of item type on student performance

The National Assessment Program – Science Literacy markers commented on the relatively large number of students who did not respond to items that required extended answers, and indeed the data supports that observation.

Table 6.6 Percentages of students omitting responses by item type

State/ Territory	Gender	Item type and per cent omits		
		Multiple-choice (MC)	Short-answer (SA)	Extended-response (ER)
ACT	Males	2.8	3.5	5.0
	Females	3.5	4.4	5.9
NSW	Males	2.1	3.4	4.5
	Females	3.4	2.7	3.7
NT	Males	7.3	8.2	11.1
	Females	6.4	7.6	7.8
QLD	Males	3.6	5.6	7.1
	Females	4.2	4.8	6.8
SA	Males	3.7	6.3	7.0
	Females	3.2	4.7	6.4
TAS	Males	2.7	6.0	6.9
	Females	2.9	4.6	5.6
VIC	Males	3.1	4.5	5.9
	Females	3.1	4.3	6.2
WA	Males	3.3	4.9	6.7
	Females	3.1	4.7	6.4
Total	Males	3.2	5.1	6.4
	Females	3.3	4.4	6.0

In nearly all cases, the proportions of students omitting responses to extended-response type items were approximately double those omitting responses to multiple-choice type items.

The percentages omitting responses in short-answer type items were generally higher than those omitting responses to multiple-choice items, but not as high as those omitting responses for extended-response type items.

There is no evidence to suggest that gender was associated with these patterns, but it appears that there was a systematic effect throughout the Scientific Literacy Scale. This raises the issue of the literacy demands created by the extended-response item types and whether these affected the level of student engagement with the test items.

6.2 Test design

6.2.1 Sample test design: cluster and unit allocation

Each booklet contained an objective test and two practical tasks. Students were only required to complete the objective test and one of the two practical tasks.

The objective tests were made up of units of work grouped into clusters. Each cluster appeared in three of the seven test booklets – once at the beginning of the paper (Block 1), once in the middle (Block 2) and once at the end of the paper (Block 3).

The following table shows how each cluster was arranged within the booklets.

Table 6.7 BIB design used in the National Assessment Program – Science Literacy 2006

Booklet	Block 1	Block 2	Block 3
1	C1	C2	C4
2	C2	C3	C5
3	C3	C4	C6
4	C4	C5	C7
5	C5	C6	C1
6	C6	C7	C2
7	C7	C1	C3

The following table shows how each unit was arranged within the clusters.

Table 6.8 Organisation of clusters

Cluster	Units (in order)	Items (ID)
C1	1. Timber properties	2 (B135,B138)
	2. States of matter	2 (B093,B096)
	3. Fossil facts	2 (B041,B044)
	4. Fibre forensics	2 (B008,B009)
	5. That's unusual	1 (B106)
	6. Tomato plants	4 (B160,B161,B162,B163)
C1 subtotal		**13**
C2	1. Energy and us	3 (B121,B122,B123)
	2. Robot	5 (B084,B085,B086,B087,B088)
	3. The effect of temperature on animal survival	4 (B046,B047,B048,B049)
	4. Stars in space	3 (B011,B012,B013)
C2 subtotal		**15**

C3	1. Mission to Mars	4 (B165,B167,B168,B170)
	2. Solid, liquid, gas	4 (B055,B056,B057, B054)
	3. Natural events	3 (B109,B110,B111)
	4. Stingray adaptations	1 (B067)
C3 subtotal		**12**
C4	1. Muffins for breakfast	3 (B190,B192,B193)
	2. Native grasslands and the striped legless lizard	3 (B113,B116,B117)
	3. The night sky	2 (B097; B098)
	4. Rock cycle	3 (B014,B015,B016)
C4 subtotal		**11**
C5	1. Breathing in, breathing out	1 (B040)
	2. Weather station	5 (B019,B020,B021,B022,B023)
	3. Phases of the moon	1 (B080)
	4. Food web of native animals	4 (B145,B146,B147,B148)
	5. Energy transfer	3 (B029,B030,B031)
C5 subtotal		**14**
C6	1. Classification of living things	3 (B076,B074,B077)
	2. Water quality monitoring	2 (B100,B103)
	3. Properties of plastics	4 (B069,B071, B068,B072)
	4. What gemstone is that?	3 (B149,B150,B152)
	5. Musical instruments	3 (B204,B207,B209)
C6 subtotal		**15**
C7	1. Cave diggers	3 (B179,B180,B181)
	2. Bar magnets	1 (B173)
	3. Camping holiday	2 (B174)
	4. Curtains	3 (B184,B185,B186)
	5. Planets	1 (B182)
	6. Bean plants	2 (B177,B178)
C7 subtotal		**11**

Notes:

Please note that due to page limitations *Energy transfer* was moved from Cluster 5 in Booklet 5 to the end of Cluster 6 in Booklet 3.

6.3 Item codes

Table 6.9 List of item codes and details

Quest trial label	Final item no.	Paper	Link1	Link2	Link3	Final q no.	Unit title
A_Q1	Item: 92	Practical	AQ02			2	Adaptations
A_Q3	Item: 93	Practical	AQ03			3	Adaptations
A_Q4	Item: 94	Practical	AQ01			1	Adaptations
A_Q6	Item: 95	Practical	AQ04			4	Adaptations
A_Q7	Item: 96	Practical	AQ05			5	Adaptations
A_Q9	Item: 97	Practical	AQ06			6	Adaptations
A_Q10	Item: 98	Practical	AQ07			7	Adaptations
A_Q12	Item: 99	Practical	AQ08			8	Adaptations
A_Q13	Item: 100	Practical	AQ09			9	Adaptations
A_Q14	Item: 101	Practical	AQ10			10	Adaptations
C_Q2	Item: 102	Practical	GQ01			1	Gravity effects
C_Q3	Item: 103	Practical	GQ02			2	Gravity effects
C_Q4	Item: 104	Practical	GQ03			3	Gravity effects
C_Q5	Item: 105	Practical	GQ04			4	Gravity effects
C_Q6	Item: 106	Practical	GQ05			5	Gravity effects
C_Q7	Item: 107	Practical	GQ06			6	Gravity effects
C_Q9	Item: 108	Practical	GQ07			7	Gravity effects
C_Q10	Item: 109	Practical	GQ08			8	Gravity effects
C_Q12	Item: 110	Practical	GQ09			9	Gravity effects
ID0B008	Item: 1	Objective	B1Q7a	B5Q33a	B7Q18a	1	Fibre forensics
ID0B009	Item: 2	Objective	B1Q7b	B5Q33b	B7Q18b	2	Fibre forensics
ID0B011	Item: 3	Objective	B1Q24	B2Q12	B6Q38	1	Stars in space
ID0B012	Item: 4	Objective	B1Q25	B2Q13	B6Q39	2	Stars in space
ID0B013	Item: 5	Objective	B1Q26	B2Q14	B6Q40	3	Stars in space
ID0B014	Item: 6	Objective	B1Q35	B3Q21	B4Q9	1	Rock cycle
ID0B015	Item: 7	Objective	B1Q36	B3Q22	B4Q10	2	Rock cycle
ID0B016	Item: 8	Objective	B1Q37	B3Q23	B4Q11	3	Rock cycle
ID0B019	Item: 9	Objective	B2Q28	B4Q13	B5Q2	1	Weather station
ID0B020	Item: 10	Objective	B2Q29	B4Q14	B5Q3	2	Weather station
ID0B021	Item: 11	Objective	B2Q30	B4Q15	B5Q4	3	Weather station
ID0B022	Item: 12	Objective	B2Q31	B4Q16	B5Q5	4	Weather station
ID0B023	Item: 13	Objective	B2Q32	B4Q17	B5Q6	5	Weather station
ID0B029	Item: 14	Objective	B2Q38	B3Q39	B4Q23	1	Energy transfer
ID0B030	Item: 15	Objective	B2Q39	B3Q40	B4Q24	2	Energy transfer
ID0B031	Item: 16	Objective	B2Q40	B3Q41	B4Q25	3	Energy transfer
ID0B040	Item: 17	Objective	B2Q27	B4Q12	B5Q1	1	Breathing in, breathing out
ID0B041	Item: 18	Objective	B1Q5	B5Q31	B7Q16	1	Fossil facts
ID0B044	Item: 19	Objective	B1Q6	B5Q32	B7Q17	2	Fossil facts
ID0B046	Item: 20	Objective	B1Q20	B2Q8	B6Q34	1	Effects of temperature
ID0B047	Item: 21	Objective	B1Q21	B2Q9	B6Q35	2	Effects of temperature
ID0B048	Item: 22	Objective	B1Q22	B2Q10	B6Q36	3	Effects of temperature
ID0B049	Item: 23	Objective	B1Q23	B2Q11	B6Q37	4	Effects of temperature

Quest trial label	Final item no.	Paper	Link1	Link2	Link3	Final q no.	Unit title
ID0B054	Item: 24	Objective	B2Q22	B3Q8	B7Q31	4	Solid, liquid, gas
ID0B055	Item: 25	Objective	B2Q19	B3Q5	B7Q28	1	Solid, liquid, gas
ID0B056	Item: 26	Objective	B2Q20	B3Q6	B7Q29	2	Solid, liquid, gas
ID0B057	Item: 27	Objective	B2Q21	B3Q7	B7Q30	3	Solid, liquid, gas
ID0B067	Item: 28	Objective	B2Q26	B3Q12	B7Q35	1	Stingray adaptation
ID0B068	Item: 29	Objective	B3Q31	B5Q19	B6Q8	3	Properties of plastics
ID0B069	Item: 30	Objective	B3Q29	B5Q17	B6Q6	1	Properties of plastics
ID0B071	Item: 31	Objective	B3Q30	B5Q18	B6Q7	2	Properties of plastics
ID0B072	Item: 32	Objective	B3Q32	B5Q20	B6Q9	4	Properties of plastics
ID0B074	Item: 33	Objective	B3Q25	B5Q13	B6Q2	2	Classification of living things
ID0B076	Item: 34	Objective	B3Q24	B5Q12	B6Q1	1	Classification of living things
ID0B077	Item: 35	Objective	B3Q26	B5Q14	B6Q3	3	Classification of living things
ID0B080	Item: 36	Objective	B2Q33	B4Q18	B5Q7	1	Phases of the moon
ID0B084	Item: 37	Objective	B1Q16	B2Q4	B6Q30	1	Robot
ID0B085	Item: 38	Objective	B1Q17	B2Q5	B6Q31	2	Robot
ID0B086	Item: 39	Objective	B1Q18	B2Q6	B6Q32	3	Robot
ID0B087	Item: 40	Objective	B1Q19a	B2Q7a	B6Q33a	4	Robot
ID0B088	Item: 41	Objective	B1Q19b	B2Q7b	B6Q33b	5	Robot
ID0B093	Item: 42	Objective	B1Q3	B5Q29	B7Q14	1	States of matter
ID0B096	Item: 43	Objective	B1Q4	B5Q30	B7Q15	2	States of matter
ID0B097	Item: 44	Objective	B1Q33	B3Q19	B4Q7	1	Night sky
ID0B098	Item: 45	Objective	B1Q34	B3Q20	B4Q8	2	Night sky
ID0B100	Item: 46	Objective	B3Q27	B5Q15	B6Q4	1	Water quality monitoring
ID0B103	Item: 47	Objective	B3Q28	B5Q16	B6Q5	2	Water quality monitoring
ID0B106	Item: 48	Objective	B1Q8	B5Q34	B7Q19	1	That's unusual
ID0B109	Item: 49	Objective	B2Q23	B3Q9	B7Q32	1	Natural events and disasters
ID0B110	Item: 50	Objective	B2Q24	B3Q10	B7Q33	2	Natural events and disasters
ID0B111	Item: 51	Objective	B2Q25	B3Q11	B7Q34	3	Natural events and disasters
ID0B113	Item: 52	Objective	B1Q30	B3Q16	B4Q4	1	Native grasslands and the striped legless lizard
ID0B116	Item: 53	Objective	B1Q31	B3Q17	B4Q5	2	Native grasslands and the striped legless lizard
ID0B117	Item: 54	Objective	B1Q32	B3Q18	B4Q6	3	Native grasslands and the striped legless lizard
ID0B121	Item: 55	Objective	B1Q13	B2Q1	B6Q27	1	Energy and us

Quest trial label	Final item no.	Paper	Link1	Link2	Link3	Final q no.	Unit title
ID0B122	Item: 56	Objective	B1Q14	B2Q2	B6Q28	2	Energy and us
ID0B123	Item: 57	Objective	B1Q15	B2Q3	B6Q29	3	Energy and us
ID0B135	Item: 58	Objective	B1Q1	B5Q27	B7Q12	1	Timber properties
ID0B138	Item: 59	Objective	B1Q2	B5Q28	B7Q13	2	Timber properties
ID0B145	Item: 60	Objective	B2Q34	B4Q19	B5Q8	1	Food web of native animals
ID0B146	Item: 61	Objective	B2Q35	B4Q20	B5Q9	2	Food web of native animals
ID0B147	Item: 62	Objective	B2Q36	B4Q21	B5Q10	3	Food web of native animals
ID0B148	Item: 63	Objective	B2Q37	B4Q22	B5Q11	4	Food web of native animals
ID0B149	Item: 64	Objective	B3Q33	B5Q21	B6Q10	1	What gemstone is that?
ID0B150	Item: 65	Objective	B3Q34	B5Q22	B6Q11	2	What gemstone is that?
ID0B152	Item: 66	Objective	B3Q35	B5Q23	B6Q12	3	What gemstone is that?
ID0B160	Item: 67	Objective	B1Q9	B5Q35	B7Q20	1	Tomato plants
ID0B161	Item: 68	Objective	B1Q10	B5Q36	B7Q21	2	Tomato plants
ID0B162	Item: 69	Objective	B1Q11	B5Q37	B7Q22	3	Tomato plants
ID0B163	Item: 70	Objective	B1Q12	B5Q38	B7Q23	4	Tomato plants
ID0B165	Item: 71	Objective	B2Q15	B3Q1	B7Q24	1	Mission to Mars
ID0B167	Item: 72	Objective	B2Q16	B3Q2	B7Q25	2	Mission to Mars
ID0B168	Item: 73	Objective	B2Q17	B3Q3	B7Q26	3	Mission to Mars
ID0B170	Item: 74	Objective	B2Q18	B3Q4	B7Q27	4	Mission to Mars
ID0B173	Item: 75	Objective	B4Q29	B6Q19	B7Q4	1	Bar magnets
ID0B174	Item: 76	Objective	B4Q30	B6Q20	B7Q5	1	Camping holiday
ID0B177	Item: 77	Objective	B4Q35	B6Q25	B7Q10	1	Bean plants
ID0B178	Item: 78	Objective	B4Q36	B6Q26	B7Q11	2	Bean plants
ID0B179	Item: 79	Objective	B4Q26	B6Q16	B7Q1	1	Cave diggers
ID0B180	Item: 80	Objective	B4Q27	B6Q17	B7Q2	2	Cave diggers
ID0B181	Item: 81	Objective	B4Q28	B6Q18	B7Q3	3	Cave diggers
ID0B182	Item: 82	Objective	B4Q34	B6Q24	B7Q9	1	Planets
ID0B184	Item: 83	Objective	B4Q31	B6Q21	B7Q6	1	Curtains
ID0B185	Item: 84	Objective	B4Q32	B6Q22	B7Q7	2	Curtains
ID0B186	Item: 85	Objective	B4Q33	B6Q23	B7Q8	3	Curtains
ID0B190	Item: 86	Objective	B1Q27	B3Q13	B4Q1	1	Muffins for breakfast
ID0B192	Item: 87	Objective	B1Q28	B3Q14	B4Q2	2	Muffins for breakfast
ID0B193	Item: 88	Objective	B1Q29	B3Q15	B4Q3	3	Muffins for breakfast
ID0B204	Item: 89	Objective	B3Q36	B5Q24	B6Q13	1	Musical instruments
ID0B207	Item: 90	Objective	B3Q37	B5Q25	B6Q14	2	Musical instruments
ID0B209	Item: 91	Objective	B3Q38	B5Q26	B6Q15	3	Musical instruments

6.4 Item analysis files

Access to the data files and output from the analyses is available to researchers or future contractors who want to replicate procedures on application to MCEETYA Secretariat at enquiries@mceetya.edu.au. Relevant data files are listed throughout the Technical Report.

6.5 Comparison of State/Territory locations in RUMM

Data showing the comparison of State/Territory locations in RUMM is provided in the file: NAPSL2006_CheckStateLocations.xls.

Chapter 7
Scaling of Test Data

7.1 Overview

The process of scaling refers to the estimation of student achievement distributions using information from students' responses to the test items. In the National Assessment Program – Science Literacy, the scaling process involved two separate phases:

7.1.1 Calibration of item parameters

The calibration of item parameters used a calibration sample in which equal numbers of respondents from each jurisdiction are included. See Section 7.2 on the selection of the calibration sample and the methodology for the calibration of item parameters.

7.1.2 Estimating student proficiency levels and producing plausible values

Once item parameters have been determined, student proficiency levels are estimated. As the main purpose of the study is to obtain profiles of student achievement at the population level, rather than at the individual student level, a methodology using plausible values (Wu 2005) was adopted.

The following sections describe in detail the two phases of the scaling process.

7.2 Calibration sample

7.2.1 Overview

To estimate item difficulty parameters, a subset of the responses called the calibration sample was used to ensure that each jurisdiction had an equal representation in the sample so that the larger States did not unduly influence the item parameter values. Since NT had the smallest number of responses, all 741 responses[12] were included in the calibration sample. For each of the other jurisdictions, a random sample of 741 responses was selected. Consequently, the calibration sample consisted of 5928 (=741×8) responses[13].

7.2.2 Data files availability

Access to the data files and output from the analyses is available under specific circumstances on application to MCEETYA Secretariat at enquiries@mceetya.edu.au.

7.2.2.1 CalibrationSample.sav

The file *CalibrationSample.sav* contains student background variables as well as item responses.

The variables with prefix 'S' (e.g. S58) are students' raw item responses. The variables with prefix 'RS' (e.g. RS58) are recoded student responses. The following rules apply to the recoding:

For the paper test, 'not reached' items are coded as 'A', and embedded missing responses remain as '9'. Students with no responses at all for the whole paper test have responses recoded to 'B'.

For the practical test, students with no responses at all have responses recoded to 'B'. Missing responses, whether not-reached or embedded, are recoded to '9'. That is, there is no 'A' code. As the two practical tests have only 9 and 10 items respectively, there does not appear to be a large number of clearly not-reached items at the end.

To calibrate the item parameters, response codes 'A' and 'B' are treated as not-administered, while response code '9' is treated as incorrect. In contrast, to calibrate the student abilities in subsequent analyses, response code 'B' is treated as not-administered, but response codes 'A' and '9' are treated as incorrect.

To match the item response variables (RS1 to RS110) to the original item codes, the variable labels column in the SPSS file can be used. The variable label for each recoded item response variable is the item code used for test development, with an 'R' at the end. For example:

---

[12] Note that one response from NT was later removed from the sample, resulting in 740 responses in the final data set.

[13] Note that in 2003, the calibration sample had only 1600 students, about one quarter of the 2006 calibration sample size.

Table 7.1 Variable names matched to the original item codes

Variable name	Variable label
RS1	ID0B008R
RS2	ID0B009R
RS48	ID0B106R
RS67	ID0B160R
RS68	ID0B161R
RS69	ID0B162R
RS70	ID0B163R

7.2.2.2 CalibrationItems.dat

This ASCII (or text) file is used as input to IRT software to calibrate the item parameters.

The codebook for this text file is given below:

Table 7.2 Codebook for *CalibrationItems.dat*

Field	Column range	
State	1–3	
Booklet ID	5	
Gender	7	
Item responses	11 to 120 (110 items in all)	The order of the items is from RS1 to RS110, in sequential order. Note that the item Pluto is in column 92. This item was removed from subsequent analyses.

7.2.3 Removal of one item in analyses

An item included in the 2006 National Assessment Program – Science Literacy test was a link item from 2003 on the topic of the solar system and the then-planet Pluto.

Table 7.3 Removed link item

2006 item ID	2003 item ID	Unit title	Unit context	Question
ID0B182	LINK03 – I0012	Planets	The solar system	Pluto is the furthest planet

Just prior to the administration of the 2006 National Assessment Program – Science Literacy test, there was a news report that scientists had downgraded the status of Pluto from planet to dwarf planet. Consequently, the item was deemed to be no longer scientifically sound and a decision was made to remove the item from all subsequent analyses.

7.2.4 IRT analysis for calibrating item parameters

The software program used to carry out the calibration of item parameters is ConQuest. A facets model is used where the test booklet number is regarded as a facet. More specifically, the model statement used in ConQuest is:

bookid + item + item*step

The full syntax of ConQuest commands is in the control file *CalibrationSample1.cqc*.

The use of the term 'bookid' in ConQuest model statements is to ensure that the estimation of the item parameters takes into account of the so-called 'booklet effect' (OECD 2005, p. 198). However, as there is only one domain in the National Assessment Program – Science Literacy 2006 (unlike PISA where there are three domains: mathematics, science and reading) and all items are calibrated together, it is not expected that there will be significant booklet effect, as is shown later in the results of the item analysis.

Three output files are produced from ConQuest:

CalibrationSample_noPluto.shw

This is a summary file, showing booklet and item parameter values, population parameter estimated and item–person maps.

CalibrationSample_noPluto.itn

This file is known as the 'itanal', showing classical test statistics as well as IRT statistics for each item.

itemparam.anc

This file is produced through an Export statement in ConQuest. It contains the values of the parameters that can be used as anchor values later when student abilities are estimated.

7.3 Estimating student proficiency levels and producing plausible values

In this phase, student proficiency levels are estimated for the full data set (NAPSL2006_Reporting_WLE_PV_20070423.sav. See Appendix H for descriptions of variables).

The scaling model used is a one-parameter item response model with conditioning variables in the population latent regression model. See PISA Technical Report for a description of the model (OECD 2005).

The conditioning variables included are

- School mean proficiency (average of students' weighted likelihood estimates for each school)
- State
- Sector
- Gender
- ATSI status
- Geolocation.

Note that the variable LBOTE is not in the above list. LBOTE was collected by OSRS; however, that information was incomplete with many missing values. Consequently, it could not be used in the scaling process.

To prepare the data to be used as conditioning variables, two separate steps are taken:

Step A: Produce WLE estimate (weighted likelihood estimate) for each student in the full data set, and compute the average WLE for each school. The software program Quest is used for the estimation of WLE estimates, with item parameters anchored at values from the Item Calibration Phase. Both embedded-missing (code '9') and not-reached items (code 'A') are treated as incorrect. If a test has no valid responses from a student, the responses (code 'B') are treated as not-administered.

Step B: Dummy variables are created for State, Sector, Gender, ATSI and Geolocation.

7.3.1 Production of plausible values

The software program ConQuest is used for the scaling of student proficiency levels and the generation of plausible values. Note that Case Weight is used in this analysis. Both booklet parameters and item parameters are anchored. Both embedded-missing (code '9') and not-reached items (code 'A') are treated as incorrect. If a test has no valid responses from a student, the responses (code 'B') are treated as not-administered. Ten plausible values are generated (instead of the usual five).

The ConQuest control file used is ***ProducePV.cqc***, shown in Appendix I.

7.4 Estimation of statistics of interest and their standard errors

Once the plausible values are produced for each student, statistics of interest can be computed together with their standard errors. For example, the mean achievement level in science for Year 6 students in Australia can be estimated, as well as jurisdiction average achievement levels. The estimates will also have associated standard errors to indicate the confidence which we have about the results.

The plausible-values methodology has been used for large-scale studies such as TIMSS, PISA and NAEP. In the National Assessment Program – Science Literacy 2006, this methodology was also used for the estimation of statistics and standard errors. For a detailed description of the methodology, see Mislevy, Beaton, Kaplan and Sheehan (1992), and Beaton and Gonzalez (1995).

Briefly, the methodology is summarised below. The plausible values for each student show the indicative level of the student's achievement. So the estimate for a population statistic is computed using the plausible values as if they represent each student's level of achievement. For example, to compute the estimated mean of the population, take the first plausible value

for each student and compute the average across students, weighted by the sampling weight (student final weight). Repeat the process with all ten plausible values, and then average the ten estimated means for the ten runs. Similarly, for the estimation of percentiles and percentages in levels, plausible values are used in the same way.

The standard errors associated with the estimated statistics are not straightforward to compute, as the sampling method is not simple random sampling but a complex two-stage sampling. Typically, for complex sampling such as the one used for NAP–SL 2006, replication methods such as Balanced Repeated Replicate (BRR) or Jackknife are used to compute standard errors (Rust & Rao 1996). In the National Assessment Program – Science Literacy 2006, the method of Jackknife was used. Jackknife replication weights are computed (variables RW1 to RW310 in the file ***NAPSL2006_Reporting_WLE_PV_20070423.sav***). The statistic of interest is computed using each of the replicate weights in turn. The variations in the estimated statistic obtained from using different replicate weights contribute to the estimate of the sampling variance for the estimated statistic. Combining this sampling variance with the variance from using the ten plausible values (measurement error) provides an estimate of the standard error for the estimated statistic.

SPSS macros were written to carry the procedures of the estimation of statistics and their standard errors.

7.5 Transform logits to a scale with mean 400 and standard deviation 100

To facilitate the interpretation of the results, it is a common practice to transform logit scores. It was decided that, for the National Assessment Program – Science Literacy surveys, the proficiency scale should have a national mean of 400 and a standard deviation of 100. This scale was chosen to avoid having negative values on the scale representing student proficiency. Further, a standard deviation of 100 provides easy interpretation of proficiency levels in terms of how far away a score is from the mean.

The transformation used in 2006 is given below.

Score on proficiency scale = (Logit–0.200543797)/0.954513216*100+400

Note that the mean of 400 is the *national* mean, computed using student sampling weights to reflect the average achievement of all Year 6 students in Australia. It is not the average of jurisdiction means, as that average does not take into account the number of students in each jurisdiction. In summary, house weights are used to set the average score of 400, not senate weights.

Chapter 8
Equating 2003 Results to 2006 Results

8.1 Setting 2006 results as the baseline

While the first cycle of the National Assessment Program – Science Literacy was conducted in 2003 (then known as PSAP), and the 2006 survey was the second round of the National Assessment Program – Science Literacy, it was decided that the 2006 survey be used to set the scale of a mean of 400 and a standard deviation of 100 (see Section 7.5), instead of the 2003 survey. The reasons for this decision are summarised below.

(1) The 2006 survey test design was more robust than the 2003 test design. In 2006, a balanced incomplete block (BIB) test design consisting of seven test booklets was used. In contrast, in 2003 only two test booklets were used, resulting in item-position effect for most items.

(2) There were considerably more items in 2006 than in 2003, resulting in a better coverage of the test contents in 2006. In 2006, 110 items were included in the final test, while only 72 items were included in the 2003 test.

(3) The 2006 survey produced a much higher population variance in achievement than 2003 did. In logits, the 2006 population standard deviation was 0.95, while the 2003 population standard deviation was 0.78. This could be an indication that:

- the 2006 items were generally more discriminating than the 2003 items; that is, the 2006 items were higher quality items
- the 2006 sampling was more comprehensive, as remote schools were also included in the sample, while the 2003 sampling focused only on areas where students were well-resourced.

8.1.1 ACER re-analysis in April 2007 of the 2003 results

Owing to errors in the weightings in the 2003 analysis, ACER carried out a re-analysis of 2003 data in April 2007. Some of the following tables contain results from the original 2003 analysis and some contain results from the 2007 re-analysis, depending on whether the 2006 analysis was carried out pre- or post-ACER re-analysis.

8.2 Equating 2003 results to 2006 results

As a consequence of the decision to use 2006 results as the baseline, 2003 results were equated to 2006 results. To carry out the equating, link items between the 2003 and 2006 tests were used.

8.2.1 Link items

The equating methodology as originally conceived in a draft paper (NAPSL06_001_TestDesign.doc) proposed that around 25 items from 2003 be embedded in the 2006 test as link items. The methodology also recommended that 15–20 items from the secure item pool of 2003 be included in the 2005 trial of items for the 2006 test.

It was important to find items that performed well statistically and also covered the range of science literacy strands A, B and C and the science concept areas: Earth and Beyond; Energy and Change; Life and Living; and Natural and Processed Materials. This reduced the number of items available. Sixteen items were selected for trialling and formed a cluster as part of the BIB design. Of these, five performed poorly at trial and were deemed inappropriate to include in the 2006 test. A concern at the small number of available link items was flagged.

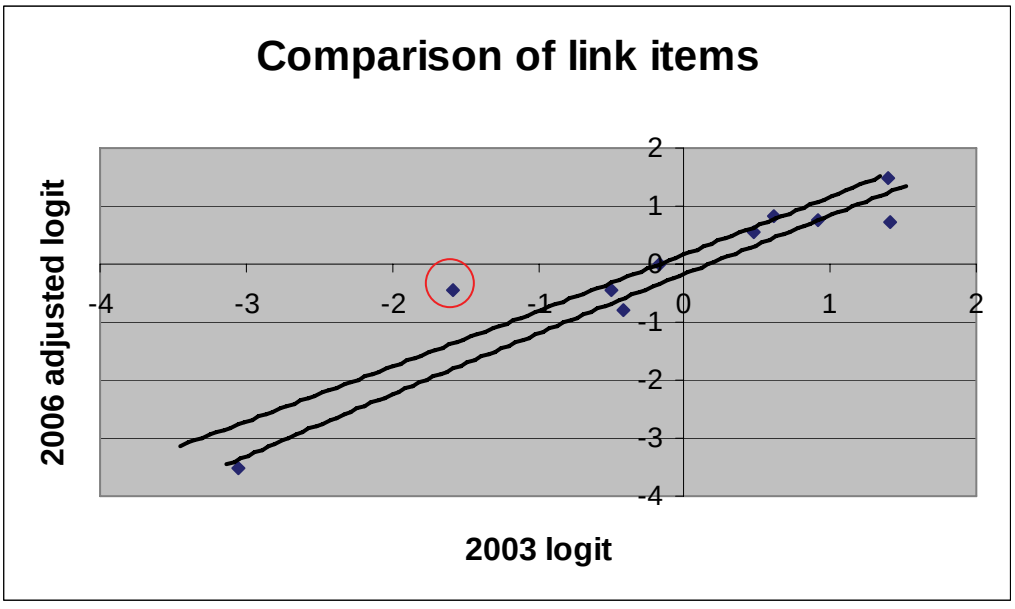
Ultimately, eleven items were approved for use as link items in the main test. These are summarised in **Table 8.1**. In the final test nine items from 2003 were included.

Table 8.1 2003–2006 link items

2006 item ID	2003 item ID	Unit title	Key	2006 calibration (free)	2003 calibration (free)[14]	Used in equating?
ID0B173	I0005	Bar magnets	1	−0.549	−0.463	yes
ID0B174	I0014	Camping holiday	D	−3.173	−3.155	yes
ID0B177	I0054	Bean plants	2	−0.152	−0.159	yes
ID0B178	I0055	Bean plants	1	1.096	1.481	yes
ID0B179	I0039	Cave diggers	1	0.485	0.970	yes
ID0B180	I0040	Cave diggers	A	0.532	0.704	yes
ID0B181	**I0041**	**Cave diggers**	**1**	**−0.546**	**−1.556**	**Removed: differing item difficulty values in 2003 and 2006**
ID0B182	**I0012**	**Planets**	**1**			**Removed: change of status of Pluto by scientists**
ID0B184	I0056	Curtains	2	0.463	1.490	yes
ID0B185	I0057	Curtains	B	−0.852	−0.391	yes
ID0B186	I0058	Curtains	A	0.305	0.528	yes

A plot of 2003 and 2006 item difficulties for the link items is given in **Figure 8.1**.

Figure 8.1 Calibrated item difficulties in 2003 and 2006 for link items



For a more detailed, step-by-step, procedure on the comparison of link items, see worksheet file ***2006-New2003ItemParameters.xls***.

[14] Note that these values are from the original 2003 calibration, not from the 2007 ACER re-analysis.

The item **Pluto** (ID0B182 – I0012) was removed from the test, as discussed in Section 7.2.3. The item circled in **Figure 8.1** (ID0B181 – I0041) was deemed to have sufficiently different item difficulty values in 2003 and 2006, so it was removed as a link item in the equating study. Consequently, nine items were used as link items for equating 2003 onto the 2006 scale.

8.3 Equating procedures

The equating procedures for the National Assessment Program – Science Literacy 2003 to 2006 followed the PISA approach to equating. The 2003 data were scaled and item parameters obtained. Using the 2003 item parameters as anchors for common items, the 2006 data were scaled and population parameters (mean and variance of ability distribution for 2006) were produced. The mean and variance from this new scaling and the mean and variance of ability distribution from the 2006 scaling (using 2006 item parameters) were then compared. A transformation was derived from mapping the mean and variance of the 2006 ability distribution obtained using 2003 item parameters onto the mean and variance of the 2006 ability distribution obtained using 2006 item parameters. This transformation was used to place 2003 results onto the 2006 scale.

It should be noted that anchor values for the 2003 item parameters were taken from the ACER re-analysis carried out in April 2007. The anchor values are shown in **Table 8.2** where the booklet parameters are taken from the 2006 calibration.

Table 8.2 2003 anchor item parameters for scaling 2006 data

```
1       –0.030 96     /* bookid 1 */
2        0.002 99     /* bookid 2 */
3        0.030 61     /* bookid 3 */
4       –0.017 15     /* bookid 4 */
5        0.030 22     /* bookid 5 */
6        0.014 42     /* bookid 6 */
7       –0.030 00     /* bookid 7 */
82      –0.496 24     /* item ID0B173 */
83      –3.053 22     /* item ID0B174 */
84      –0.163 41     /* item ID0B177 */
85       1.398 88     /* item ID0B178 */
86       0.908 96     /* item ID0B179 */
87       0.619 73     /* item ID0B180 */
89       1.415 72     /* item ID0B184 */
90      –0.416 23     /* item ID0B185 */
91       0.476 52     /* item ID0B186 */
117     –1.563 63     /* item ID0B177 step 1 */
118     –1.044 69     /* item ID0B184 step 1 */
```

The control file for this anchored run is similar to that in Appendix I, except for changing the import statement by referring to the 2003 anchor file.

8.4 Equating transformation

The result of the equating process was the derivation of a transformation formula for 2003 results to be placed on the 2006 scale. This equation is given below.

2003 result on 2006 scale = ((2003 logit – 0.5215) / 0.9595) * 0.9545) + 0.2005

The above transformation essentially performs a constant shift of around –0.32. The scale factor is very close to 1, indicating that an adjustment of the scale factor is not really necessary.

For standard errors, the transformation involved only the scale factor, as follows:

2003 standard error on 2006 scale in logit = (2003 S.E. in logit) / 0.9595 * 0.9545

8.5 Link error

In establishing trends from 2003 to 2006, it is necessary to make judgments about the statistical significance of the difference in science achievement between 2003 and 2006. An appropriate estimation of the magnitude of equating errors is important when trends are reported. An underestimate of the equating errors will often result in erroneous claims of change in achievement levels when there is no significant difference.

Equating errors come from at least two sources: the sampling of students and the sampling of items. Equating errors due to the sampling of students affect the accuracy with which the item parameters are estimated, and the magnitude of these errors diminishes when the sample size increases. However, equating errors due to the sampling of items have not often been taken into account, and the magnitude of these errors does not diminish when the sample size increases. For the estimates of population parameters (e.g. mean), the magnitude of equating errors due to the sampling of items tends to be much larger than the magnitude of equating errors due to the sampling of students. Consequently, it is important to estimate the equating error due to the sampling of items.

Following the approach used in PISA (OECD 2005), equating error (called 'link error' in PISA) is computed as follows: calibrate the items using 2003 and 2006 data separately. If the link items behave exactly the same way in 2003 and 2006 (and they follow the Rasch model), there should only be a constant difference between 2003 and 2006 item parameters for matched items. However, in real life, items will vary from 2003 to 2006 and some items will vary more than others. The degree to which the item parameters change from 2003 to 2006 can be assessed in the following way. Take the difference between 2003 and 2006 item difficulties for each link item, where the 2003 item difficulties have been placed on the 2006 scale. Compute the standard error of the mean of the differences. This standard error is used as equating error due to the sampling of items. **Table 8.3** shows the computation.

Table 8.3 Computation of link error

Item ID	2003 difficulty on 2006 scale	2006 difficulty	2003 – 2006
/* item ID0B173 */	–0.811 686 33	–0.549	0.262 686
/* item ID0B174 */	–3.355 528 12	–3.173	0.182 528
/* item ID0B177 */	–0.480 566 47	–0.152	0.328 566
/* item ID0B178 */	1.073 696 218	1.096	0.022 304
/* item ID0B179 */	0.586 293 512	0.485	–0.101 29
/* item ID0B180 */	0.298 549 625	0.532	0.233 45
/* item ID0B184 */	1.090 449 691	0.463	–0.627 45
/* item ID0B185 */	–0.732 087 43	–0.852	–0.119 91
/* item ID0B186 */	0.156 075 463	0.305	0.148 925
/* item ID0B177 step	–1.873 591 89	–1.194 33	0.679 262
/* item ID0B184 step	–1.357 318 3	–0.859 32	0.497 998
Standard error (logit)			0.104 825
Standard error (400/100)			10.98

The link error is used only when comparisons between 2003 and 2006 results are made. For example, to test whether the mean achievement in 2003 differs from the mean achievement in 2006, the link error is added to the standard error of the difference, as illustrated in **Table 8.4**.

Table 8.4 Standard error of difference

	2003 mean on 2006 scale & s.e.	2006 mean & s.e.	2003 mean – 2006 mean	Standard error of difference	Standardised difference
NSW	417 (3.89)	411 (3.26)	6	$12 = \sqrt{3.89^2 + 3.26^2 + 10.98^2}$	0.5 = 6/12 n.s.

Chapter 9
Proficiency Scale and Proficiency Levels

For reporting purposes, student results are often summarised through the definition of a number of proficiency levels. That is, the proficiency scale is divided into a number of levels, with descriptions of skills attached to each level, and percentages of students at various levels are reported.

In 2003, cut-points along the proficiency scale were decided after consultations with experts in the area of science. It was decided that for 2006 the same cut-points would be used.

To set the cut-points for 2006, the 2003 cut-points in logits are transformed onto the 2006 scale, as shown in **Table 9.1**.

Table 9.1 Cut-points for the National Assessment Program – Science Literacy 2006

Level	2003 cut-points (logit)	Transformed to 2006 scale[15]	Transformed to 400/100 scale[16]
2 and below	up to –0.8	–1.113 89	262.2932
3.1	up to 0.45	0.129 692	392.5772
3.2	up to 1.7	1.373 269	522.8611
3.3	up to 2.95	2.616 846	653.145
4.0	above 2.95		

[15] The transformation used is (2003 logit–0.521218)/0.959443*0.954513216+0.200543797.

[16] The transformation used is scaled score=(2006 logit–0.200543797)/0.954513216*100+400.

As for 2003, a response probability of 0.65 is used to place items in proficiency levels. **Table 9.2** shows the National Assessment Program – Science Literacy 2006 items and their corresponding levels on the proficiency scale.

Table 9.2 Proficiency levels of items

Item	2006 difficulty	2006 item difficulty after adjustment for RP	Level	Design level	Secure for 2009	Scaled score
ID0B008	0.936	1.555	3.3	2		542
ID0B009	0.445	1.064	3.2	3		490
ID0B011	−0.610	0.009	3.1	2		380
ID0B012	−0.536	0.083	3.1	4		388
ID0B013	−0.153	0.466	3.2	5		428
ID0B014	−0.715	−0.096	3.1	1		369
ID0B015	−0.327	0.292	3.2	3		410
ID0B016	0.222	0.841	3.2	4		467
ID0B019	0.605	1.224	3.2	3	Y	507
ID0B020	1.073	1.692	3.3	3	Y	556
ID0B021	0.976	1.595	3.3	3	Y	546
ID0B022	−0.213	0.406	3.2	4	Y	422
ID0B023	1.200	1.819	3.3	5	Y	570
ID0B029	1.331	1.950	3.3	4		583
ID0B030	0.685	1.304	3.2	4		516
ID0B031	1.000	1.619	3.3	3		549
ID0B040	−0.900	−0.281	3.1	3	Y	350
ID0B041	−1.077	−0.458	3.1	3	Y	331
ID0B044	−0.441	0.178	3.2	4	Y	398
ID0B046	−1.726	−1.107	3.1	3		263
ID0B047	1.068	1.687	3.3	3		556
ID0B048	−1.695	−1.076	3.1	3		266
ID0B049	0.382	1.001	3.2	3		484
ID0B054	3.249	3.868	5	4		784
ID0B055	−1.244	−0.625	3.1	3		314
ID0B056	0.475	1.094	3.2	3		494
ID0B057	1.037	1.656	3.3	4		552
ID0B067	0.334	0.953	3.2	4	Y	479
ID0B068	1.328	1.947	3.3	4		583
ID0B069	−2.303	−1.684	2	2		203
ID0B071	−1.540	−0.921	3.1	3		283
ID0B072	−0.772	−0.153	3.1	3		363
ID0B074	0.040	0.659	3.2	4		448
ID0B076	−1.972	−1.353	2	3		237
ID0B077	−0.313	0.306	3.2	4		411
ID0B080	−0.088	0.531	3.2	3		435
ID0B084	−0.462	0.157	3.2	3	Y	395

ID0B085	−0.355	0.264	3.2	3	Y	407
ID0B086	1.906	2.525	3.3	3	Y	644
ID0B087	−0.371	0.248	3.2	4	Y	405
ID0B088	−0.587	0.032	3.1	4	Y	382
ID0B093	−2.289	−1.670	2	1		204
ID0B096	−0.462	0.157	3.2	3		395
ID0B097	−1.256	−0.637	3.1	2	Y	312
ID0B098	0.223	0.842	3.2	4	Y	467
ID0B100	−0.734	−0.115	3.1	3		367
ID0B103	1.384	2.003	3.3	3		589
ID0B106	−1.213	−0.594	3.1	3	Y	317
ID0B109	−1.404	−0.785	3.1	3		297
ID0B110	0.317	0.936	3.2	3		477
ID0B111	−1.543	−0.924	3.1	3		282
ID0B113	−0.266	0.353	3.2	3		416
ID0B116	0.132	0.751	3.2	3		458
ID0B117	2.450	3.069	4	5		701
ID0B121	−0.157	0.462	3.2	2	Y	427
ID0B122	0.259	0.878	3.2	2	Y	471
ID0B123	1.888	2.507	3.3	4	Y	642
ID0B135	−0.388	0.231	3.2	2	Y	403
ID0B138	0.971	1.590	3.3	4	Y	546
ID0B145	0.327	0.946	3.2	3		478
ID0B146	2.323	2.942	4	4		687
ID0B147	−0.258	0.361	3.2	2		417
ID0B148	1.890	2.509	3.3	4		642
ID0B149	−0.839	−0.220	3.1	2	Y	356
ID0B150	−0.343	0.276	3.2	3	Y	408
ID0B152	−0.455	0.164	3.2	3	Y	396
ID0B160	0.025	0.644	3.2	3	Y	446
ID0B161	1.453	2.072	3.3	4	Y	596
ID0B162	1.357	1.976	3.3	2	Y	586
ID0B163	1.877	2.496	3.3	4	Y	640
ID0B165	−1.712	−1.093	3.1	2		264
ID0B167	−0.748	−0.129	3.1	4		365
ID0B168	0.849	1.468	3.3	4		533
ID0B170	1.876	2.495	3.3	4		640
ID0B173	−0.549	0.070	3.1	3	Y	386
ID0B174	−3.173	−2.554	2	2	Y	111
ID0B177	−0.152	0.467	3.2	4	Y	428
ID0B178	1.096	1.715	3.3	3	Y	559
ID0B179	0.485	1.104	3.2	3	Y	495
ID0B180	0.532	1.151	3.2	3	Y	500
ID0B181	−0.546	0.073	3.1	3	Y	387

ID0B184	0.463	1.082	3.2	4	Y	492
ID0B185	−0.852	−0.233	3.1	2	Y	355
ID0B186	0.305	0.924	3.2	3	Y	476
ID0B190	−3.388	−2.769	2	1	Y	89
ID0B192	−0.846	−0.227	3.1	3	Y	355
ID0B193	−0.672	−0.053	3.1	4	Y	373
ID0B204	0.837	1.456	3.3	3		532
ID0B207	−0.268	0.351	3.2	4		416
ID0B209	1.152	1.771	3.3	3		565
A_Q1	−1.931	−1.312	2	1	Y	242
A_Q3	−0.666	−0.047	3.1	2	Y	374
A_Q4	−1.466	−0.847	3.1	3	Y	290
A_Q6	0.942	1.561	3.3	3	Y	543
A_Q7	−0.367	0.252	3.2	3	Y	405
A_Q9	−0.816	−0.197	3.1	4	Y	358
A_Q10	0.422	1.041	3.2	2	Y	488
A_Q12	1.567	2.186	3.3	3	Y	608
A_Q13	−0.854	−0.235	3.1	3	Y	354
A_Q14	0.549	1.168	3.2	3	Y	501
C_Q2	−0.663	−0.044	3.1	1		374
C_Q3	−0.267	0.352	3.2	3		416
C_Q4	0.723	1.342	3.2	4		520
C_Q5	−0.675	−0.056	3.1	3		373
C_Q6	1.724	2.343	3.3	3		624
C_Q7	−0.897	−0.278	3.1	4		350
C_Q9	0.762	1.381	3.3	4		524
C_Q10	2.397	3.016	4	4		695
C_Q12	−0.334	0.285	3.2	3		409

References

Biggs, J. and Collis, K. (1982) Evaluating the quality of learning: the SOLO taxonomy. New York: Academic Press.

Beaton, A.E. and Gonzalez, E. (1995) NAEP primer. Chestnut Hill, MA, Boston College: Boston.

Mislevy, R.J., Beaton, A.E., Kaplan, B. and Sheehan, K.M. (1992) Estimating population characteristics from sparse matrix samples of item responses. *Journal of Educational Measurement*, 29, pp. 133–161.

IEA (2004) TIMSS 2003 technical report.

OECD (2005) PISA 2003 technical report.

Rust, K.F. and Rao, J.N.K. (1996) Variance estimation for complex surveys using replication techniques. *Statistical Methods in Medical Research*, Vol. 5, Hodder Arnold, London, pp. 283–310.

Wu, M.L. (2005) The role of plausible values in large-scale surveys. Postlethwaite (ed.). Special Issue of *Studies in Educational Evaluation* (SEE) in memory of R.M. Wolf. 31 (2005) pp. 114–128.

Appendix A
National Year 6 Primary Science Assessment Domain

A.1. Assessment domains: scientific literacy

The national review of the status and quality of teaching and learning of science in Australian schools (Goodrum, Hackling & Rennie 2001) argued that the broad purpose of science in the compulsory years of schooling is to develop scientific literacy for all students.

Scientific literacy is a high priority for all citizens, helping them to:

- be interested in and understand the world around them
- engage in the discourses of and about science
- be sceptical and questioning of claims made by others about scientific matters
- be able to identify questions, investigate and draw evidence-based conclusions
- make informed decisions about the environment and their own health and wellbeing.

Scientific literacy is important as it contributes to the economic and social wellbeing of the nation and improved decision making at public and personal levels (Laugksch 2000).

PISA focuses on aspects of preparedness for adult life in terms of functional knowledge and skills that allow citizens to participate actively in society. It is argued that scientifically-literate people are 'able to use scientific knowledge and processes not just to understand the natural world but also to participate in decisions that affect it' (OECD 1999, p. 13).

The OECD–PISA defined scientific literacy as:

> *the capacity to use scientific knowledge, to identify questions (investigate)*[17] *and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity.*
>
> (OECD 1999, p. 60)

This definition has been adopted for the national assessment of Science Literacy (NAP-SL) in accord with the Ball, Rae and Tognolini (2000) report recommendation.

A.2. Scientific literacy: progress map

A scientific literacy progress map was developed based on the construct of scientific literacy and on an analysis of State and Territory curriculum and assessment frameworks. The progress map describes the development of science literacy across three strands of knowledge which are inclusive of Ball et al.'s concepts and processes and the elements of the OECD–PISA definition.

The five elements of scientific literacy, including concepts and processes used in PISA 2000 (OECD–PISA 1999), include:

- demonstrating understanding of scientific concepts
- recognising scientifically investigable questions
- identifying evidence needed in a scientific investigation
- drawing or evaluating conclusions
- communicating valid conclusions.

These elements have been clustered into three, more holistic strands which have been described below. The second and third elements and conducting investigations to collect data are encompassed in strand A; the fourth and fifth elements and conducting investigations to collect data are included in strand B; and the first element is included in strand C.

Strand A: Formulating or identifying investigable questions and hypotheses, planning investigations and collecting evidence

This process strand includes posing questions or hypotheses for investigation or recognising scientifically investigable questions; planning investigations by identifying variables and devising procedures where variables are controlled; gathering evidence through measurement

[17] Because of the constraints of large-scale testing, PISA was not able to include performance tasks such as conducting investigations. Consequently, its definition of scientific literacy omitted reference to investigating. The word 'investigate' was inserted into the definition for the purposes of the National Science Assessment, as the sample testing methodology to be used allowed for assessments of students' ability to conduct investigations.

and observation; and making records of data in the form of descriptions, drawings, tables and graphs using a range of information and communications technologies.

Strand B: Interpreting evidence and drawing conclusions from their own or others' data, critiquing the trustworthiness of evidence and claims made by others, and communicating findings

This process strand includes identifying, describing and explaining the patterns and relationships between variables in scientific data; drawing conclusions that are evidence-based and related to the questions or hypotheses posed; critiquing the trustworthiness of evidence and claims made by others; and communicating findings using a range of scientific genres and information and communications technologies.

Strand C: Using science understandings for describing and explaining natural phenomena, and for interpreting reports about phenomena

This conceptual strand includes demonstrating conceptual understandings by being able to: describe, explain and make sense of natural phenomena; understand and interpret reports (e.g. TV documentaries, newspaper or magazine articles or conversations) related to scientific matters; and make decisions about scientific matters in students' own lives which may involve some consideration of social, environmental and economic costs and benefits.

Scientific literacy has been described here in three strands to facilitate the interpretation of student responses to assessment tasks. However, authentic tasks should require students to apply concepts and processes together to address problems set in real-world contexts. These tasks may involve ethical decision making about scientific matters in students' own lives and some consideration of social, environmental and economic costs and benefits.

The scientific literacy progress map describes progression in six levels from 1 to 6 in terms of three aspects:

- increasing complexity, from explanations that involve one aspect to several aspects, and then through to relationships between aspects of a phenomenon
- progression from explanations that refer to and are limited to directly experienced phenomena (concrete) to explanations that go beyond what can be observed directly and involve abstract scientific concepts (abstract); and
- progression from descriptions of 'what' happened in terms of the objects and events, in explanations of 'how' it happened in terms of processes, to explanations of 'why' it happened in terms of science concepts.

The process strands (strands A and B) are based on the WA and VIC assessment profiles, as these most clearly describe these learning outcomes.

The conceptual strand (strand C) has been abstracted across conceptual strands and makes no reference to particular concepts or contexts. As the progression in the conceptual domain

is based on increasing complexity and abstraction, links have been made to the Structure of Observed Learning Outcomes (SOLO) taxonomy (Biggs & Collis 1982).

The taxonomy was written to describe levels of student responses to assessment tasks. The basic SOLO categories include:

prestructural	no logical response
unistructural	refers to only one aspect
multistructural	refers to several independent aspects
relational	can generalise (describe relationships between aspects) within the given or experienced context; and
extended abstract	can generalise to situations not experienced.

The three main categories of unistructural, multistructural and relational can also be applied, as cycles of learning, to the four modes of representation:

sensorimotor	the world is understood and represented through motor activity
iconic	the world is represented as internal images
concrete	writing and other symbols are used to represent and describe the experienced world; and
formal	the world is represented and explained using abstract conceptual systems.

The conceptual strand (strand C) of the progress map therefore makes links to the SOLO categories of concrete unistructural (level 1), concrete multistructural (level 2), concrete relational (level 3), abstract unistructural (level 4), abstract multistructural (level 5) and abstract relational (level 6).

The SOLO levels of performance should not be confused with Piagetian stages of cognitive development. Biggs and Collis (1982, p. 22) explain that the relationship between Piagetian stages and SOLO levels 'is exactly analogous to that between ability and attainment' and that level of performance depends on quality of instruction, motivation to perform, prior knowledge and familiarity with the context. Consequently performance for a given individual is highly variable and often sub-optimal.

The agreed proficiency standards serve to further elaborate the progress map. Level 3 is now described as 3.1, 3.2, 3.3. A 'proficient' standard is a challenging level of performance, with students needing to demonstrate more than minimal or elementary skills.

Table A.1 Scientific Literacy Progress Map – July 2004 version from DEST Science Education Assessment Resource (SEAR) project

Level	SOLO taxonomy	Strands of scientific literacy		
		Strand A Formulating or identifying investigable questions and hypotheses, planning investigations and collecting evidence. Process strand: experimental design and data gathering.	**Strand B** Interpreting evidence and drawing conclusions from their own or others' data, critiquing the trustworthiness of evidence and claims made by others, and communicating findings. Process strand: interpreting experimental data.	**Strand C** Using understandings for describing and explaining natural phenomena, and for interpreting reports about phenomena. Conceptual strand: applies conceptual understanding.
6	Abstract relational	Uses scientific knowledge to formulate questions, hypotheses and predictions and to identify the variables to be changed, measured and controlled. Trials and modifies techniques to enhance reliability of data collection.	Selects graph type and scales that display the data effectively. Conclusions are consistent with the data, explain the patterns and relationships in terms of scientific concepts and principles, and relate to the question, hypothesis or prediction. Critiques the trustworthiness of reported data (e.g. adequate control of variables, sample or consistency of measurements, assumptions made in formulating the methodology), and consistency between data and claims.	Explains complex interactions, systems or relationships using several abstract scientific concepts or principles and the relationships between them. SOLO: Abstract relational
5	Abstract multi-structural	Formulates scientific questions or hypotheses for testing and plans experiments in which most variables are controlled. Selects equipment that is appropriate and trials measurement procedure to improve techniques and ensure safety. **When provided with an experimental design involving multiple independent variables, can identify the questions being investigated.**	Conclusions explain the patterns in the data using science concepts, and are consistent with the data. Makes specific suggestions for improving/extending the existing methodology (e.g. controlling an additional variable, changing an aspect of measurement technique). Interprets/compares data from two or more sources. **Critiques reports of investigations noting any major flaw in design or inconsistencies in data.**	Explains phenomena, or interprets reports about phenomena, using several abstract scientific concepts. **SOLO: Abstract multistructural**
4	Abstract unistructural	Formulates scientific questions, identifies the variable to be changed, the variable to be measured and in addition identifies at least one variable to be controlled. Uses repeated trials or replicates. Collects and records data involving two or more variables.	Calculates averages from repeat trials or replicates, plots line graphs where appropriate. Interprets data from line graph or bar graph. Conclusions summarise and explain the patterns in the science data. Able to make general suggestions for improving an investigation (e.g. make more measurements).	Explains interactions, processes or effects that have been experienced or reported, in terms of a non-observable property or abstract science concept. SOLO: Abstract unistructural

3	Concrete relational	Formulates simple scientific questions for testing and makes predictions. Demonstrates awareness of the need for fair testing and appreciates scientific meaning of 'fair testing'. Identifies variable to be changed and/or measured but does not indicate variables to be controlled. Makes simple standard measurements. Records data as tables, diagrams or descriptions.	Displays data as tables or constructs bar graphs when given the variables for each axis. Identifies and summarises patterns in science data in the form of a rule. Recognises the need for improvement to the method. Applies the rule by extrapolating and predicting.	Describes the relationships between individual events (including cause and effect relationships) that have been experienced or reported. Can generalise and apply the rule by predicting future events. SOLO: Concrete relational
2	Concrete multi-structural	Given a question in a familiar context, identifies that one variable/factor is to be changed (but does not necessarily use the term 'variable' to describe the changed variable). Demonstrates intuitive level of awareness of fair testing. Observes and describes or makes non-standard measurements and limited records of data.	Makes comparisons between objects or events observed. Compares aspects of data in a simple supplied table of results. Can complete simple tables and bar graphs given table column headings or prepared graph axes.	Describes changes to, differences between or properties of objects or events that have been experienced or reported. SOLO: Concrete multistructural
1	Concrete unistructural	Responds to the teacher's questions and suggestions, manipulates materials and observes what happens.	Shares observations; tells, acts out or draws what happened. Focuses on one aspect of the data.	Describes (or recognises) one aspect or property of an individual object or event that has been experienced or reported. SOLO: Concrete unistructural

A comparison of the 2003 and 2004 conceptual frameworks shows that the changes are elaborations that serve to clarify the content of the cells of the map. In particular, the elaborations assist in further describing the progression from student descriptions of 'what' happened to 'how' it happened (concrete), to explanations of 'why' it happened (abstract).

Major scientific concepts in the National Assessment Program – Science Literacy

A table of the major scientific concepts found most widely in the various State and Territory curriculum documents has been developed to accompany the scientific literacy map (see **Table A.2**).

These major concepts are broad statements of scientific understandings that Year 6 students would be expected to demonstrate. They provided item writers with a specific context in which to assess scientific literacy. An illustrative list of examples for each of the major concepts provides elaboration of these broad conceptual statements and, in conjunction with the scientific literacy map, which describes the typical developmental stages for scientific literacy, was used as a guide for the development of assessment items.

It should be noted that, because the National Assessment Program – Science Literacy test instruments were constructed within the constraints of test length, it will not be feasible to include all the listed concepts in instruments constructed for a specific testing cycle.

Table A.2 Major scientific concepts in the National Assessment Program – Science Literacy 2006

Major scientific concepts	Examples
Earth and Beyond	
Earth, sky and people: Our lives depend on air, water and materials from the ground; the ways we live depend on landscape, weather and climate. The changing Earth: The Earth is composed of materials that are altered by forces within and upon its surface. Our place in space: The Earth and life on Earth are part of an immense system called the universe.	Features of weather, soil and sky and effects on me. Changes in weather, weather data, seasons, soil landscape and sky (e.g. moon phases), weathering and erosion, movement of the Sun and shadows, bush fires, land clearing. People use resources from the earth; need to use them wisely. Rotation of the Earth and night/day, spatial relationships between Sun, Earth and Moon. Planets of our solar system and their characteristics.
Energy and Change	
Energy and us: Energy is vital to our existence and our quality of life as individuals and as a society. Transferring energy: Interaction and change involve energy transfers; control of energy transfer enables particular changes to be achieved. Energy sources and receivers: Observed change in an object or system is indicated by the form and amount of energy transferred to or from it	Uses of energy, patterns of energy use and variations with time of day and season. Sources, transfers, carriers and receivers of energy, energy and change. Types of energy, energy of motion – toys and other simple machines – light, sound. Forces as pushes and pulls, magnetic attraction and repulsion.
Life and Living	
Living together: Organisms in a particular environment are interdependent. Structure and function: Living things can be understood in terms of functional units and systems. Biodiversity, change and continuity: Life on Earth has a history of change and disruption, yet continues generation to generation.	Living vs non-living. Plant vs animal and major groups. Major structures and systems and their functions. Dependence on the environment: Survival needs – food, space and shelter. Change over lifetime, reproductions and lifecycles. Interactions between organisms and interdependence (e.g. simple food chains). Adaptation to physical environment.
Natural and Processed Materials	
Materials and their uses: The properties of materials determine their uses; properties can be modified. Structure and properties: The substructure of materials determines their behaviour and properties. Reactions and change: Patterns of interaction of materials enable us to understand and control those interactions.	Materials have different properties and uses. The properties of materials can be explained in terms of their visible substructure, such as fibres. Materials can change their state and properties. Solids, liquids and gases.

Appendix B
Sample School Reports

Ministerial Council on Education, Employment, Training and Youth Affairs

THE UNIVERSITY OF NEW SOUTH WALES
EDUCATIONAL ASSESSMENT AUSTRALIA

Curriculum CORPORATION

Sam Sample
Sampleville Primary School
Sampleville Road
Sampleville VIC 3804

Dear Sam Sample

Re: National Assessment Program – Science Literacy (2006)

On behalf of Educational Assessment Australia and Curriculum Corporation I wish to thank you, your staff and Year 6 students for participating in the Ministerial Council on Education, Employment, Training and Youth Affairs (MCEETYA) National Assessment Program – Science Literacy in October this year.

We appreciate the effort your staff made to ensure that the assessment was administered consistently, completed and returned to us.

Enclosed with this letter are the reports for participating Year 6 students at your school. There are two reports for each student: one for the pencil and paper (objective) test and one for the practical task.

There are seven A4 report sheets – one for each of the seven test booklets used in the national assessment. The results for each student for the pencil and paper (objective) test are located on the A4 report sheet corresponding to the objective test booklet they completed. The student's results for the practical task are located on the one A3 report sheet. All participating students at your school performed the same practical task.

We have included an information sheet to help interpret these reports. Please provide a copy of this information to anyone requesting these results.

Please pass on our thanks to the staff and students involved in this National Assessment Program – Science Literacy.

Yours sincerely

Dr Jenny Donovan
Project Director

Ministerial Council on Education, Employment, Training and Youth Affairs

THE UNIVERSITY OF NEW SOUTH WALES
EDUCATIONAL ASSESSMENT AUSTRALIA

Curriculum CORPORATION

National Assessment Program – Science Literacy (2006)

Interpreting the student reports

Each Year 6 student completed one of the seven different pencil and paper (objective) test forms and one of two practical tasks. The student reports provide information about each student's achievement on the particular objective test and practical task that s/he completed. Each item tested appeared in three of the seven test booklets in a different position. So although each test booklet was different there were commonalities between the booklets. Each test booklet comprised a different number of questions and only one third of the questions were common with another booklet. Therefore, the total score achieved by any one student can only be compared to other students completing the same booklet.

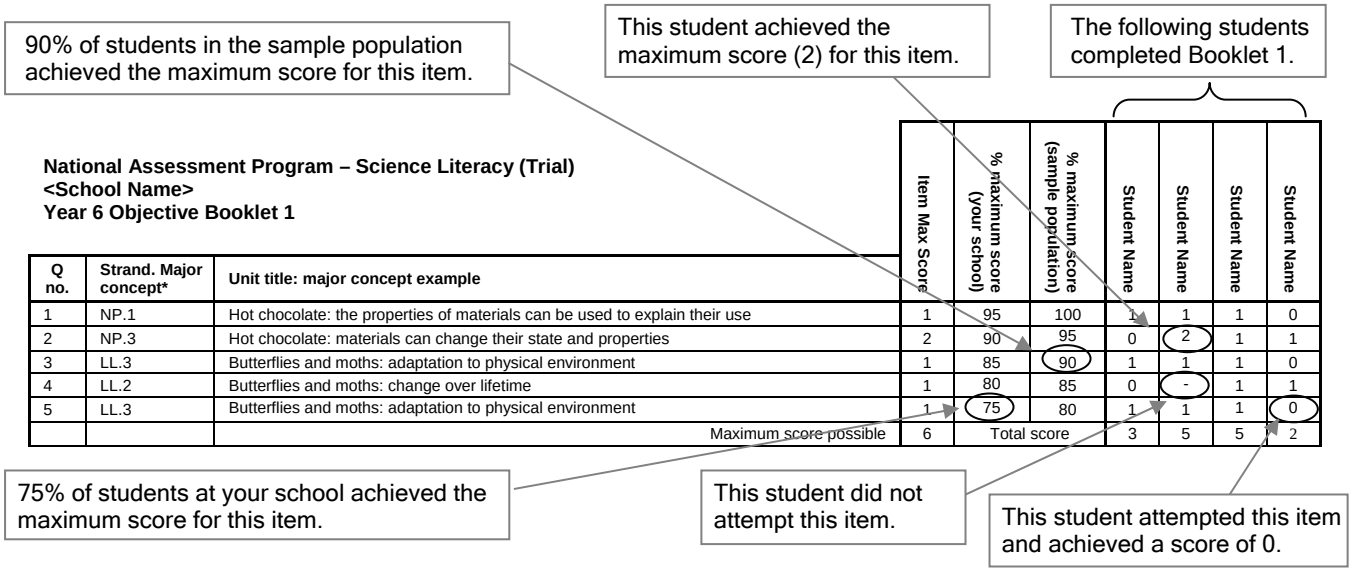
The objective test report and the practical task report include the following information:

1. the relevant science strand and major concept addressed by each question (please refer to the key at the end of the A3 practical task report for more information)
2. a description of the skill tested by the question – practical task report only
3. a description of the question context and major concept examples – objective test booklets only
4. the maximum possible score for each item and the percentage of students in the school (across multiple booklets) who achieved that score
5. the percentage of students in the national sample population who achieved the maximum score on each item (the sample population contains approximately 5% of the total Year 6 national population)
6. the name of each student who completed the test for the corresponding test booklet, his/her achievement on each item and overall score on the test.

These reports can be used to:

7. compare your students' achievement on each item against the sample population (by comparing the two columns showing the % of students attaining the maximum score)
8. compare student achievement within the seven booklets and practical task by looking at the maximum possible score and the total for each student for each test
9. identify areas in the curriculum and strands that may need to be covered in more detail by examining the performance of students in each strand/major concept.

Below is part of a sample report form with some key information explained.



National Assessment Program – Science Literacy 2006

Sampleville Primary School

Year 6 Objective Booklet 1

Q no.	Strand. Major concept*	Unit title: major concept example	Item max score	% maximum score (your school)	% maximum score (sample population)	Student name	Student name	Student name	Student name	Student name	Student name
1	NP.2	Timber properties: hardwood linked to flowering trees	1	63	62	1	1	1	0	0	1
2	NP.2	Timber properties: why old-growth forests are valued	1	42	34	0	1	0	0	1	0
3	NP.1	States of matter: mass of gases	1	84	89	1	1	1	0	1	1
4	NP.1	States of matter: fire extinguishers	1	68	64	1	1	1	1	0	1
5	EB.2	Fossil facts: changes to soil surface	1	89	75	1	1	1	1	0	1
6	EB.2	Fossil facts: changes in landscape	1	53	63	0	1	0	0	1	0
7a	NP.2	Fibre forensics: the properties of materials can be explained in terms of their visible substructure	1	47	36	1	1	-	1	1	1
7b	NP.2	Fibre forensics: the properties of materials can be explained in terms of their visible substructure	1	32	45	0	1	0	0	0	1
8	NP.2	That's unusual: change of state	1	79	76	1	1	1	0	1	1
9	LL.2	Tomato plants: dependence on the environment	1	42	53	1	1	0	0	0	1
10	LL.2	Tomato plants: dependence on the environment	1	11	26	0	0	1	0	1	0
11	LL.3	Tomato plants: reproduction and lifecycles	1	32	26	0	0	0	1	0	0
12	LL.3	Tomato plants: reproduction and lifecycles	1	37	19	0	0	0	0	0	0
13	EC.1	Energy and us: renewable energy resources; uses of energy	1	60	59	1	1	1	1	1	0
14	EC.1	Energy and us: renewable energy resources; uses of energy	1	45	50	0	1	0	0	1	0
15	EC.1	Energy and us: renewable energy resources; uses of energy	1	15	19	0	0	1	0	1	0
16	EC.3	Robot: links components to outputs i.e. battery (energy source)	1	75	63	0	1	1	0	1	1
17	EC.3	Robot: energy receivers transform energy into another form	1	75	61	1	1	1	1	1	1
18	EC.3	Robot: in a motor energy is lost through heat and sound	1	15	20	0	0	0	0	0	0
19a	EC.1	Robot: advantages of renewable energy as energy source	1	65	62	0	1	1	0	1	1
19b	EC.1	Robot: disadvantages of renewable energy as energy source	1	70	66	0	1	1	1	-	1
20	LL.3	Effects of temperature: adaptation to physical environment	1	75	82	1	1	1	0	1	1
21	LL.3	Effects of temperature: adaptation to physical environment	1	35	32	0	1	0	0	0	1
22	NP.3	Effects of temperature: materials can change their state and properties	1	75	82	0	1	0	0	1	1
23	LL.2	Effects of temperature: dependence on the environment; survival needs	1	70	45	1	1	1	0	1	0
24	EB.3	Stars in space: formation of stars	1	50	65	0	1	1	0	0	1
25	EB.3	Stars in space: nothing travels fast enough to escape the pull of gravity	1	65	63	1	1	1	0	1	0
26	EB.3	Stars in space: light cannot escape a black hole therefore they are black	1	70	56	1	1	1	0	1	1
27	NP.1	Muffins for breakfast: properties can be modified	1	90	95	1	1	1	0	1	1
28	NP.1	Muffins for breakfast: properties of materials determine their uses	1	85	71	1	1	0	0	1	1
29	NP.1	Muffins for breakfast: properties of materials determine their uses	1	70	67	1	1	1	0	0	-
30	LL.3	Native grasslands and the striped legless lizard: human impact on grasslands	1	70	60	1	1	1	0	0	1
31	LL.1	Native grasslands and the striped legless lizard: feeding relationship in an ecosystem (food chain)	1	80	51	1	1	0	1	0	1
32	LL.3	Native grasslands and the striped legless lizard: experimental design: collecting evidence	1	10	13	0	0	0	0	0	0
33	EB.3	Night sky: chart of the night sky	1	90	76	1	1	1	0	1	1
34	EB.3	Night sky: table of apparent brightness	1	45	49	0	1	1	1	0	0
35	EB.2	Rock cycle: processes involved in the formation of metamorphic rocks	1	70	68	1	0	0	0	0	1
36	EB.2	Rock cycle: processes involved in the formation of sedimentary rocks	1	75	59	1	1	0	0	1	0
37	EB.2	Rock cycle: environmental conditions relating the formation of different rock types	1	55	49	0	1	1	1	0	1
		Maximum score possible	**39**	**Total score**		**21**	**32**	**23**	**10**	**21**	**24**

* Refer to the key on the last page of this report document

National Assessment Program – Science Literacy 2006

Sampleville Primary School

Year 6 Practical Task: Gravity effects

Major concept example: planets of our solar system and their characteristics

Strand. Major concept: EB.3*

Q no.	Item descriptor	Item max score	% maximum score (your school)	% maximum score (sample population)	Student name	Student name	Student name	Student name	Student name	Student name	Student name	Student name	Student name	Student name	Student name	Student name	Student name	Student name	Student name	Student name	Student name
1	focuses on one aspect of the data	1	53	68	1	1	0	0	0	1	1	0	0	1	0	0	1	1	1	1	0
2	records data as descriptions	1	65	59	0	0	1	1	1	1	0	0	1	1	1	1	1	1	0	1	0
3	recognises purpose of calculating average from trials	1	41	39	0	0	0	0	1	0	0	1	0	0	1	1	1	0	1	1	0
4	records data as descriptions	1	71	68	-	1	1	1	1	0	0	0	0	1	1	1	1	1	1	1	1
5	identifies factors that contribute to a fair test	1	59	21	0	0	0	0	1	0	1	1	0	1	1	1	1	1	1	0	1
6	identifies hypothesis being tested	1	94	71	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
7	plots line graph	1	12	38	0	0	0	-	0	0	0	0	0	1	0	1	0	0	0	0	0
8	summarises patterns in the data	1	6	13	0	0	-	0	0	0	0	0	0	0	0	0	0	1	0	0	0
9	makes a prediction from data	1	71	61	1	1	1	0	0	1	1	1	1	0	1	1	0	1	1	0	1
	Maximum score possible	**9**	**Total score**		**3**	**4**	**4**	**3**	**5**	**4**	**4**	**4**	**3**	**6**	**6**	**7**	**6**	**7**	**6**	**4**	**4**

A science literacy progress map has been developed based on the construct of science literacy and on an analysis of State and Territory curriculum and assessment frameworks. A table of the major scientific concepts (listed below) found most widely in the various State and Territory documents has been developed to accompany the science literacy progress map. These major concepts are broad statements of scientific understandings that Year 6 students would be expected to demonstrate. For further details please visit www.mceetya.edu.au

***KEY: strand/major scientific concepts**

Strand:
EB = Earth and Beyond

Major scientific concepts

EB.1 = Earth, sky and people: Our lives depend on air, water and materials from the ground; the ways we live depend on landscape, weather and climate.

EB.2 = The changing Earth: The Earth is composed of materials that are altered by forces within and upon its surface.

EB.3 = Our place in space: The Earth and life on Earth are part of an immense system called the universe.

Strand:
EC = Energy and Change

Major scientific concepts

EC.1 = Energy and us: Energy is vital to our existence and our quality of life as individuals and as a society.

EC.2 = Transferring energy: Interaction and change involve energy transfers; control of energy transfer enables particular changes to be achieved.

EC.3 = Energy sources and receivers: Observed change in an object or system is indicated by the form and amount of energy transferred to or from it.

Strand:
LL = Life and Living

Major scientific concepts

LL.1 = Living together: Organisms in a particular environment are interdependent.

LL.2 = Structure and function: Living things can be understood in terms of functional units and systems.

LL.3 = Biodiversity, change and continuity: Life on Earth has a history of change and disruption, yet continues generation to generation.

Strand:
NP = Natural and Processed Materials

Major scientific concepts

NP.1 = Materials and their uses: The properties of materials determine their uses; properties can be modified.

NP.2 = Structure and properties: The substructure of materials determines their behaviour and properties.

NP.3 = Reactions and change: Patterns of interaction of materials enable us to understand and control those interactions.

Appendix C
Item Pool Feedback

Table C.1 Item pool feedback: EAA, CC and SLRC

Item	24/02/06 Item inclusion	24/02/06 Item comment	06/04/06 Item inclusion	06/04/06 Item comment	7/04/06 Item inclusion
A_Q1	Y	Amber NESBDIFF, yet item 2 (similar wording but longer) is green NESBDIFF. "Look at your results for XXX in Table 1. When you used the craft sticks, how many beads did Person 1 gather?" Perhaps confusion about when "you" used the sticks and "Person 1's results" if person 1 wasn't them? Other stats fine.	Y	agree on prac decisions	Y
A_Q10	Y	No issues.	Y		Y
A_Q11	Y	Amber discrimination: 17%omitted. Location 2.09 - moderately difficult item. Marking scheme OK. Perhaps confusion over the wording of the item: Why were you asked to keep person 1,2,3 the same in both parts of the thumb experiment?" Other stats fine.	Y		N
A_Q12	Y	Amber gender: girls better than boys. Item requires student to complete and compare table of results on tasks using and not using the thumb. Other stats fine. Pending overall gender DIF balance of pool.	Y		Y
A_Q13	Y	No issues.	Y		Y
A_Q14	Y	No issues.	Y		Y
A_Q15	Y	No issues.	Y		N
A_Q2	Y	No issues. Also refer to item 1	Y	Preferred BEMU EAA & CC	Y
A_Q3	Y	No issues.	Y		Y
A_Q4	Y	No issues.	Y		Y
A_Q5	Y	No issues.	Y		N
A_Q6	Y	No issues.	Y		Y
A_Q7	Y	No issues.	Y		Y
A_Q8	Y	No issues.	Y		N
A_Q9	Y	No issues.	Y		Y
B_Q1	Y	No issues.	N		N
B_Q10	Y	Amber discrimination and 0.19 location. Other stats fine. 4 option MC. Item involved matching energy transfer in freewheeling a bike downhill to the actions in the model ramp. Relatively difficult item. Mean ability and pt bis OK.	N	Incorrect inclusion status changed to blue	N

Item	24/02/06 Item inclusion	24/02/06 Item comment	06/04/06 Item inclusion	06/04/06 Item comment	7/04/06 Item inclusion
B_Q11	Y	No issues.	N	Incorrect inclusion status changed to red	N
B_Q12	N	Red discrimination; amber residual fit & NESBDIF. MC item applying knowledge of potential energy to position of a cart on a hill. Not difficult. Relatively even count of responses to each distracter perhaps suggests some guessing? Mean ability indicates most able students selected D.	N		N
B_Q13	Y	Amber discrimination. 4 option MC item. Item involves energy changes when going downhill. Mean ability for option A (0.36) and B [Key] (0.46). A and B differ in order of energy change only.	N		N
B_Q2	Y	Amber gender: boys answered twice as well as girls. “Why were you asked to complete 3 trials.....?” Other stats fine. Pending overall gender DIF balance of pool.	N		N
B_Q3	Y	No issues.	N		N
B_Q4	N	Amber discrimination 0.19 but location 1.10. Item contains the answer to the question? “Which feature was changed in the experiment using the positions A and B on the ramp?” Other stats fine.	N		N
B_Q5	Y	Amber NESBDIFF. MC Item written in the conditional tense (prediction); Descriptor: “Half cup would move a smaller distance than before”, perhaps meaning of “before” is not clear?. 3 option MC. Mean ability of students selecting correct response [C] appropriate (0.37); others negative. Point bis OK. No indication of guessing. Other stats fine.	N		N
B_Q6	Y	No issues.	N		N
B_Q7	Y	Amber %correct. Score 2,1 . Few would have scored 2 as marking scheme required all 5 variables (score 1 required at least one variable). Consequently those naming 4 variables got score 1, whereas 5 variables scored 2. NB Level 5 item. Quest Itanal reveals that threshold for 1pt = -0.81; 2pt = 4.04. Mean ability 2pt = 1.22; 1pt = 0.44. Pt bis reversed for [1] and [2]. Could collapse to 0,1.	N	retain as 0, 1, 2	N
B_Q8	Y	Amber gender: favoured girls. Score 2,1. Item involved observation AND explanation of marble rolling on paper and on sandpaper. Greater % of girls and boys scored 2 than 1 which is unexpected. Other stats fine. Pending overall gender DIF balance of pool.	N	retain as 0, 1, 2	N

Item	24/02/06 Item inclusion	24/02/06 Item comment	06/04/06 Item inclusion	06/04/06 Item comment	7/04/06 Item inclusion
B_Q9	Y	No issues.	N		N
C_Q1	N	Red (negative) discrimination. First item in the prac. Relatively easy (-2.64). “When you used the one-clip bob, what were your results for trial 3?” 2nd item very similar in content also has red discrimination & relatively easy -2.93.	N		N
C_Q10	Y	No issues.	Y		Y
C_Q11	N	Very difficult (4.99).Red discrimination. 90% scored 0. Q wording? “Why is height lost”. Also marking scheme may have benefited with more examples of correct answers? Pt bis reversed.	N		N
C_Q12	Y	Amber gender. Boys did better than girls. 4 option MC item relating to pendulum behaviour on planets; perhaps boys more familiar with context. Other stats fine. Pending overall gender DIF balance of pool.	Y		Y
C_Q13	N	Amber fit residual; red discrimination; EM involving circling 2 alternatives (larger/smaller; slower/faster) to score 1. Final item in test paper but only 7% omitted so didn’t run out of time.	N		N
C_Q2	Y	Red discrimination. Relatively easy (-2.93). 1st item very similar in content also has red discrimination, but mean ability on this item is ok. Pending no. of very easy items in pool.	Y	agree on prac decisions	Y
C_Q3	Y	No issues.	Y		Y
C_Q4	Y	No issues.	Y		Y
C_Q5	Y	No issues.	Y		Y
C_Q6	Y	No issues.	Y		Y
C_Q7	Y	No issues.	Y		Y
C_Q8	N	Red discrimination.17% omitted. Level 5. Location 3.38. Marking scheme: All 3 variables required for score 1. Perhaps would have fared better if it were a score 2,1 item? Mean ability ok, but pt bis reversed.	N		N
C_Q9	Y	No issues.	Y		Y
D_Q1	Y	Amber discrimination. First item. Reason? “What was the greatest distance stretched by the green fabric in Experiment 1?” Very easy item; mean ability and pt bis ok.	N	agree on prac decisions	N
D_Q10	Y	No issues.	N		N

Item	24/02/06 Item inclusion	24/02/06 Item comment	06/04/06 Item inclusion	06/04/06 Item comment	7/04/06 Item inclusion
D_Q11	Y	Amber discrimination. Only MC item in this prac. "What would be the most likely reason for Annie's result for fabric X in Trial 3? Option C was attractive (weaker students). Perhaps students were reading more into the item than necessary i.e. wasn't intended to be focusing on concept of 'average'. Mean ability and pt bis ok.	N	66.25 average, keep, no clear reason for objection	N
D_Q12	N	Very difficult (4.60). Red discrimination (0.12). 18% omitted. Marking scheme demanding: all controlled variables required for score 1.Item 6 tests same concept.	N		N
D_Q13	Y	Amber NESBDIF. "Based on your experiments 1 and 2, which fabric has the best stretch properties for use in making sportswear?" Perhaps grammatical construction difficult for NESB. Other stats fine.	N		N
D_Q14	N	Amber fit residual (-3.31);amber NESBDIF (plus M.Wu dif report) perhaps due to long sentence in item. Highly discriminating.	N		N
D_Q2	Y	Stats ok, but refer to item 3 which also asked for the calculation of an average (& resulted in some amber stats). Easy item; mean ability and pt bis ok.	N		N
D_Q3	Y	Amber discrimination. Marking scheme allowed for rounding up or down of the calculated averages to nearest whole number. Marker commented on how students often took the middle figure on the table rather than calculating the average. Rounding up or down was often incorrect. The calculation involved averaging 3 small figures (eg. 0, 0.5, 0.0 which was sometimes incorrectly calculated when rounding up or down. Item 2 also required calculation of an average (involving figures>1.00), resulting in OK stats. Easy item; mean ability and pt bis ok.	N		N
D_Q4	Y	No issues.	N		N
D_Q5	Y	No issues.	N		N
D_Q6	N	Amber fit residual (3.15) & discrimination (0.21). "Which features were kept the same"? Actual number of features not specified but score 1 required at least one controlled variable (out of a possible 10 or so). Moderately difficult item; mean ability and pt bis ok.	N		N
D_Q7	Y	No issues.	N		N
D_Q8	Y	No issues.	N		N

Item	24/02/06 Item inclusion	24/02/06 Item comment	06/04/06 Item inclusion	06/04/06 Item comment	7/04/06 Item inclusion
D_Q9	Y	Amber gender. Boys did better than girls. “What advantage would there be in Jack using several trials instead of one for each weight”...to stretch the material. Marking scheme required a reason be provided as to why a larger range would be advantageous. Relatively difficult item; mean ability and pt bis ok. Pending overall gender DIF balance of pool.	N		N
E_Q1	Y	Location -3.14 (rel easy); Red discrimination (0.09). “What happened to the water when you used the card?” Similar stats for the next item, item 2 (location -2.79 and red discrimination 0.06). “What happened to the water when you used the paper towel?” Pending no. of very easy items in pool.	N		N
E_Q10	Y	No issues.	N		N
E_Q11	N	Amber fit residual (2.81) and discrimination (0.19).MC item on test variable. Only MC item in prac. Poor distracters? % correct options A and B [key] and mean ability suggests guessing.	N		N
E_Q12	Y	No issues.	N	Retain, valid skill assessed	N
E_Q13	Y	No issues.	N		N
E_Q14	Y	No issues.	N		N
E_Q2	Y	Red discrimination (0.06) and Location -2.79. Too easy? Also refer to item 1. Pending no. of very easy items in pool.	N		N
E_Q3	Y	No issues.	N	Legitimate skill assessed, retain	N
E_Q4	Y	No issues.	N		N
E_Q5	Y	No issues.	N		N
E_Q6	Y	No issues.	N		N
E_Q7	Y	No issues.	N		N
E_Q8	Y	No issues.	N		N
E_Q9	Y	Amber NESBDIF. “How many cups would you need to use in this planned experiment? Explain your answer.” Grammatical structure difficult for NESB? Mean ability and pt bis ok.	N		N
ID0B001	N	poor stats	N		N

Item	24/02/06 Item inclusion	24/02/06 Item comment	06/04/06 Item inclusion	06/04/06 Item comment	7/04/06 Item inclusion
ID0B002	N	only one viable therefore both discarded	N		N
ID0B003	N	Very easy item (easiest item in data set);Discrimination 0.22. Count zero for option D MC. Suggest remove and retain Q3 (also easy item).	N		N
ID0B004	Y	No issues.	Y	agree on unit decisions	N
ID0B005	Y	Very easy item; Discrimination 0.22. Retain. Move earlier in set. Delete first stimulus. Edit second stimulus.	Y		N
ID0B006	Y	No issues.	Y		N
ID0B007	Y	No issues.	Y		N
ID0B008	Y	No issues.	Y	agree on unit decisions	Y
ID0B009	Y	% correct just outside green (39.72%); no other issues. Format is 3 option MC. Mean ability of students selecting correct response [B] appropriate (0.5); others negative. Point bis OK. No indication of guessing.	Y		Y
ID0B010	Y	No issues.	Y		N
ID0B011	Y	No issues.	Y	ok	Y
ID0B012	Y	No issues.	Y	ok	Y
ID0B013	Y	Low % correct for 2pt. Quest Itanal reveals that threshold for 1pt = -0.16; 2pt = 3.25. Mean ability 2pt = 1.56; 1pt = 0.33. Pt bis close [0.25 (1), 0.32(2)]. Difficult concept. Could collapse to 0,1.	Y	collapse to 0,1?	Y
ID0B014	Y		Y		Y
ID0B015	Y		Y		Y
ID0B016	Y		Y	all good	Y
ID0B017	N	poor stats	N		N
ID0B018	Y	note RUMM & QUEST Chi-square (p) both <0.05 + NESB dif*	Y		N
ID0B019	Y		Y		Y
ID0B020	Y	hard	Y		Y
ID0B021	Y	hard	Y		Y
ID0B022	Y		Y		Y

Item	24/02/06 Item inclusion	24/02/06 Item comment	06/04/06 Item inclusion	06/04/06 Item comment	7/04/06 Item inclusion
ID0B023	Y	maybe yes - fit is OK*	Y	all good	Y
ID0B024	Y		Y	agree on unit decisions	N
ID0B025	Y		Y		N
ID0B026	Y	note gender dif	Y		N
ID0B027	Y	hard; possibly omit	Y		N
ID0B028	Y	hard	Y	BEMU comment however retain for unit	N
ID0B029	Y	Slightly favours boys (RUMM). % correct < 40; other stats fine. Item refers to knowledge of energy sources. Other items in unit do not favour boys, therefore unlikely to be context of invention that favours boys. Mean ability and pt bis OK. Tag for balance against items favouring girls.	Y	all good but potentially could be ditched	Y
ID0B030	Y	% correct < 40; other stats fine. Mean ability and pt bis: Mean ability 1pt = 0.60; 0 pt =-0.27; ptbis 1pt = 0.43; 0 pt = - 0.33.	Y		Y
ID0B031	Y	No issues.	Y		Y
ID0B032	N	Fit too high (RUMM & QUEST = 1.24); Check item type against Discrimination; % correct <40. Mean ability 1pt = 0.24; 0 pt =- 0.07; ptbis 1pt = 0.17; 0 pt = -0.09. Could consider removing, but might raise unit face validity issue i.e. might be open to criticism if a question addressing whether or not the invention will work is not included. High fit suggests difficult for students to predict and provide explanation in context of abstract model. Pending consideration of overall unit context.	N		N
ID0B033	Y		N	remove unit post discussion	N
ID0B034	Y	note QUEST Chi-square (p) <0.05 + NESB dif*	N		N
ID0B035	Y	note QUEST Chi-square (p) <0.05 + gender dif*	N		N
ID0B036	Y		N		N
ID0B037	Y		N		N
ID0B038	Y	note RUMM and QUEST chi-square probability values <0.05	N		N
ID0B039	Y		N		N

Item	24/02/06 Item inclusion	24/02/06 Item comment	06/04/06 Item inclusion	06/04/06 Item comment	7/04/06 Item inclusion
ID0B040	Y		Y	Agree	Y
ID0B041	Y	No issues.	Y		Y
ID0B042	Y	No issues.	Y		N
ID0B043	Y	% correct < 40%; discrimination borderline. Open item. Mean ability 1pt = 0.43; 0 pt =0.01; ptbis 1pt = 0.24; 0 pt = -0.03. Relatively difficult item.	Y		N
ID0B044	Y	No issues.	Y	all good	Y
ID0B045	Y	Slightly favours girls (RUMM); other stats fine. Item requires written explanation drawing on data presented in table form. Other items in unit do not favour girls, therefore unlikely to be context of temperature regulation that favours girls. Mean ability and pt bis OK. Tag for balance against items favouring girls.	Y	agree on unit decisions	N
ID0B046	Y	No issues.	Y		Y
ID0B047	Y	% correct < 40; other stats fine. 4 option MC. Mean ability of students selecting correct response [D] appropriate (0.52); others negative. Point bis OK. No indication of guessing.	Y		Y
ID0B048	Y	No issues.	Y		Y
ID0B049	Y	No issues.	Y		Y
ID0B050	N	poor stats; omit image	N		N
ID0B051	Y		Y	agree on unit decisions	Y
ID0B052	Y		Y		Y
ID0B053	Y		Y		Y
ID0B054	Y	very hard; reorder in set	Y		Y
ID0B055	Y		Y		Y
ID0B056	Y	note QUEST Chi-square (p) <0.05	Y		Y
ID0B057	Y	note gender dif	Y	all good	Y
ID0B058	Y	note RUMM Chi-square (p) <0.05	N	remove unit post discussion	N
ID0B059	Y		N		N
ID0B060	Y		N		N
ID0B061	Y	note RUMM Chi-square (p) <0.05	N		N

Item	24/02/06 Item inclusion	24/02/06 Item comment	06/04/06 Item inclusion	06/04/06 Item comment	7/04/06 Item inclusion
ID0B062	N	low disc	N		N
ID0B063	N	low disc	N		N
ID0B064	N	low disc	N		N
ID0B065	N	deleted because of other non-viables	N		N
ID0B066	N	deleted because of other non-viables	N		N
ID0B067	Y		Y	agree; collapse to 0, 1 score	Y
ID0B068	Y	potentially delete a	Y	agree on unit decisions	Y
ID0B069	Y	note RUMM Chi-square (p) <0.05 + QUEST	Y		Y
ID0B070	N		N		N
ID0B071	Y		Y		Y
ID0B072	Y		Y		Y
ID0B073	Y	delete graph; position later in set; change name from Sven	N	more numeracy	N
ID0B074	Y		Y	keep other items	Y
ID0B075	N	note QUEST Chi-square (p) <0.05	N		N
ID0B076	Y	note RUMM & QUEST Chi-square (p) <0.05; consider position	Y		Y
ID0B077	Y		Y		Y
ID0B078	Y	note RUMM & QUEST Chi-square (p) <0.05	Y	changed both to Y	N
ID0B079	Y	note RUMM & QUEST Chi-square (p) <0.05	Y	Suggest collapse 2 to 1pt, 1pt to 0	N
ID0B080	Y	reduce stimulus; omit first paragraph	Y	ok	Y
ID0B081	N	stats poor	N		N
ID0B082	N	stats poor	N		N
ID0B083	N	stats poor	N		N
ID0B084	Y	Strongly favours boys (RUMM & QUEST); other stats fine. Q4 also (slightly) favours boys; indicating context may be more familiar to boys.Q1 requires knowledge of battery as energy source. Tag for balance against items favouring girls.	Y		Y
ID0B085	Y	No issues.	Y		Y

Item	24/02/06 Item inclusion	24/02/06 Item comment	06/04/06 Item inclusion	06/04/06 Item comment	7/04/06 Item inclusion
ID0B086	Y	% correct < 40; other stats fine. Open item. Mean ability and pt bis OK. Mean ability 1pt = 0.49; 0 pt = - 0.02; ptbis 1pt = 0.28; 0 pt = -0.15.	Y		Y
ID0B087	Y	Slightly favours boys (RUMM); other stats fine. Required to give one advantage of a solar-powered toy compared to a battery-operated toy. Tag for balance against items favouring girls. Could remove a or b	Y		Y
ID0B088	Y	No issues.	Y	all good	Y
ID0B089	Y	No issues.	Y	agree on unit decisions	N
ID0B090	Y	No issues.	Y		N
ID0B091	Y	No issues.	Y		N
ID0B092	Y	% correct <40; other stats fine. Open item. Mean ability and pt bis OK. Mean ability 1pt = 0.70; 0 pt = - 0.07; ptbis 1pt = 0.47; 0 pt = - 0.22.	Y		N
ID0B093	Y		Y	agree on unit decisions	Y
ID0B094	N	stats poor	N		N
ID0B095	Y	note gender and NESB dif; slightly easier for girls	Y		Y
ID0B096	Y	note QUEST Chi-square (p) <0.05	Y		Y
ID0B097	Y		Y		Y
ID0B098	Y		Y		Y
ID0B099	Y	note QUEST Chi-square (p) <0.05 (free response - field knowledge)	Y	all good	N
ID0B100	Y		Y	agree decisions	Y
ID0B101	N	check this item-type; issue re collection of Y/N data; consider collapsing questions	N		N
ID0B102	Y		N	misinterpretation & BEMU	N
ID0B103	Y		Y		Y
ID0B104	N	poor stats	N		N

Item	24/02/06 Item inclusion	24/02/06 Item comment	06/04/06 Item inclusion	06/04/06 Item comment	7/04/06 Item inclusion
ID0B105	Y	Favours NESB (RUMM); other stats fine. EM item. Unit requires selection of words from cards provided - perhaps this format favours non ESB students (also applies to Q4 in unit). However, Q2 and Q3 do not show favouring NESB.	Y	agree on unit decisions	N
ID0B106	Y	No issues.	Y		Y
ID0B107	Y	Discrimination borderline; favours NESB (RUMM) - see comment for Q1. EM item. Mean ability and pt bis OK. Mean ability 1pt = 0.22; 0 pt = - 0.22; ptbis 1pt = 0.24; 0 pt = - 0.18.	Y		N
ID0B108	Y	No issues.	Y		N
ID0B109	Y	Discrimination borderline. 4 option MC. Mean ability of students selecting correct response [C] appropriate (0.25); others negative. Point bis OK. No indication of guessing. Relatively easy item.	Y		Y
ID0B110	Y	Strongly favours boys (RUMM & QUEST); other stats fine. MC. Q2 requires application of knowledge of processes underlying movement of tectonic plates. Only item in set favouring boys, so context not likely to be problematic per se. Tag for balance against items favouring girls.	Y		Y
ID0B111	Y	No issues.	Y		Y
ID0B112	Y	% correct <40; other stats fine. Open item. Relatively difficult item (1.50 RUMM; 1.58 QUEST). Mean ability and pt bis OK. Mean ability 1pt = 0.80; 0 pt = 0.09; ptbis 1pt = 0.37; 0 pt = - 0.02.	Y	all good	N
ID0B113	Y	No issues.	Y	agree on unit decisions	Y
ID0B114	Y	% correct <40 for 1pt and 2pt. Other stats fine. Low % correct for 2pt. Quest Itanal reveals that threshold for 1pt = 0.03.16; 2pt = 0.87. Mean ability 2pt = 0.65; 1pt = 0.54. Pt bis close [0.26 (1), 0.35(2)]. Could collapse to 0,1.	Y	retain as 0, 1, 2	Y
ID0B115	N	Fit too high (RUMM & QUEST). 4 option MC. Mean ability of students selecting correct response [B] appropriate (0.20); others negative. Point bis OK. No indication of guessing. Relatively easy item. May not fit as spatial/visual awareness may be tested rather than experimental design as such.	N		N
ID0B116	Y	No issues. Could reduce stimulus	Y	Changed A to B Aver 66 as set works well	Y

Item	24/02/06 Item inclusion	24/02/06 Item comment	06/04/06 Item inclusion	06/04/06 Item comment	7/04/06 Item inclusion
ID0B117	Y	% correct <40; other stats fine. Open item. Relatively difficult item. Mean ability and pt bis OK. Mean ability 1pt = 0.77; 0 pt = 0.07; ptbis 1pt = 0.37; 0 pt = - 0.05.	Y		Y
ID0B118	Y	No issues. Could reduce stimulus	Y	agree on unit decisions	N
ID0B119	N	Fit too low (RUMM); other stats fine. Mean ability 1pt = 0.71; 0 pt = - 0.34; ptbis 1pt = 0.56; 0 pt = - 0.34. Low fit may be due to overly familiar context (environmentally-friendly).	N		N
ID0B120	Y	Favours NESB (RUMM); % correct < 40.Open item. No apparent reason for why item format would favour NESB (in fact high reading load and grammatically complex). Mean ability 1pt = 0.71; 0 pt = - 0.15; ptbis 1pt = 0.45; 0 pt = - 0.24.	Y		N
ID0B121	Y	No issues.	Y	all good	Y
ID0B122	Y	No issues.	Y		Y
ID0B123	Y	% correct <40; other stats fine. Open item. Mean ability and pt bis OK. Mean ability 1pt = 0.75; 0 pt = - 0.02; ptbis 1pt = 0.40; 0 pt = - 0.16. Relatively difficult item.	Y		Y
ID0B124	Y	note NESB dif	Y	agree on unit decisions	N
ID0B125	Y	note RUMM & QUEST Chi-square (p) <0.05	Y		N
ID0B126	Y		Y		N
ID0B127	N	low disc	N		N
ID0B128	Y		Y		N
ID0B129	Y		N		N
ID0B130	Y	No issues.	Y		N
ID0B131	Y	% correct <40; other stats fine. Moderately difficult item. Open item. Mean ability and pt bis OK. Mean ability 1pt = 0.46; 0 pt = - 0.06; ptbis 1pt = 0.30; 0 pt = - 0.22. Moderately difficult item.	Y	all good	N
ID0B132	Y	No issues.	Y	agree on unit decisions	N

Item	24/02/06 Item inclusion	24/02/06 Item comment	06/04/06 Item inclusion	06/04/06 Item comment	7/04/06 Item inclusion
ID0B133	Y	Strongly favours girls (RUMM & QUEST); favours nonNESB (RUMM) - check. 'Three separate' containers difficult construction for NESB but easy for nonNESB? No apparent reason item would favour girls in terms of context. Item asks for explanation related to experimental design. Open item. Mean ability and pt bis OK. Mean ability 1pt = 0.34; 0 pt = - 0.48; ptbis 1pt = 0.43; 0 pt = - 0.48. Relatively easy item. Pending overall gender DIF balance of pool.	Y		N
ID0B134	Y	Strongly favours girls (RUMM & QUEST); other stats fine. No apparent reason item would favour girls in terms of context. Item asks for conclusion related to experimental results. Open item. Mean ability and pt bis OK. Mean ability 1pt = 0.37; 0 pt = - 0.12; ptbis 1pt = 0.32; 0 pt = - 0.17. Relatively easy item. Pending overall gender DIF balance of pool.	Y		N
ID0B135	Y		Y	agree on unit decisions	Y
ID0B136	N	low disc	N		N
ID0B137	Y		Y		Y
ID0B138	Y	note RUMM Chi-square (p) <0.05	Y		Y
ID0B139	Y	note gender dif	N		N
ID0B140	N	Discrimination borderline; other stats fine. Mean ability difference 0.17. Easy item. Pending no. of items of similar difficulty in pool.	N		N
ID0B141	N	No issues.	N		N
ID0B142	N	Fit too high; discrimination too low. Mean ability indicates that more able students selecting A and B (incorrect distracters). Student have focused on concrete aspects of the game rather than the scientific principles behind the game.	N		N
ID0B143	N	Low % correct; low discrimination - check. Difficult item and concepts. Complex MC format: for correct response, students needed to consider a combination of three aspects of the game and the associated energy change for each. Mean ability similar for correct answer [B] and incorrect [D]. 50.2% selected D. There is only one difference between these options. For 'Marina swings her arm', Movement energy has been selected instead of 'chemical energy'. Suggest students lack understanding of chemical energy concept.	N		N

Item	24/02/06 Item inclusion	24/02/06 Item comment	06/04/06 Item inclusion	06/04/06 Item comment	7/04/06 Item inclusion
ID0B144r	N	note disc	N		N
ID0B145r	Y	Review instructions and placement of instructions next to item set	Y	agree on unit decisions	Y
ID0B146r	Y	note disc	Y		Y
ID0B147	Y		Y		N
ID0B148	Y		Y		Y
ID0B149	Y	Favours nonNESB (RUMM); other stats fine. MC. NonNESB may be advantaged due to unfamiliar names of minerals (too unfamiliar for NESB). Relatively easy item	Y	all good	Y
ID0B150	Y	No issues.	Y		Y
ID0B151	N	Fit too low (RUMM); other stats fine. = Low fit may be due to unusual construct of item: student has to interpret table then apply to draw conclusion using logic.	N		N
ID0B152	Y	No issues.	Y		Y
ID0B153	N	note: QUEST Chi-square (p) <0.05 + gender dif	N		N
ID0B154	Y		Y	OK but potentially lose this unit	N
ID0B155	Y		Y		N
ID0B156	N	low disc	N		N
ID0B157	Y		Y		N
ID0B158	N	check this item-type; potentially collapse set	N		N
ID0B159	Y		Y		N
ID0B160	Y	No issues.	Y	agree on unit decisions	N
ID0B161	Y	% correct < 40; other stats fine. Open item. Mean ability and pt bis OK. Mean ability 1pt = 0.73; 0 pt = 0.00; ptbis 1pt = 0.46; 0 pt = - 0.29.Moderately difficult item.	Y		N

Item	24/02/06 Item inclusion	24/02/06 Item comment	06/04/06 Item inclusion	06/04/06 Item comment	7/04/06 Item inclusion
ID0B162	Y	Strongly favours boys (RUMM & QUEST); % correct < 40. 4 option MC. Mean ability of students selecting correct response [D] appropriate (0.32); B and C negative, with A [0.14] . Point bis OK. No indication of guessing. Moderately difficult item. Item requires student to interpret bar graph. Pending overall gender DIF balance of pool.	Y		N
ID0B163	Y	% correct < 40; other stats fine. Relatively difficult item.	Y		N
ID0B164	Y	% correct < 40; other stats fine. Relatively difficult item.	Y		N
ID0B165	Y	note RUMM & QUEST Chi-square (p) <0.05	Y		Y
ID0B166	Y	note QUEST Chi-square (p) <0.05	Y		N
ID0B167	Y		Y		Y
ID0B168	Y	note QUEST Chi-square (p) <0.05	Y		Y
ID0B169	Y	note QUEST Chi-square (p) <0.05	Y		N
ID0B170	Y	note QUEST Chi-square (p) <0.05	Y	all good	Y
ID0B171	Y		N	Removed low disc	N
ID0B172	Y		N	Removed low disc	N
ID0B173	Y		Y		Y
ID0B174	Y		Y		Y
ID0B175	Y		N	Removed low disc	N
ID0B176	Y		N	Removed low disc	N
ID0B177	Y		Y		Y
ID0B178	Y		Y		Y
ID0B179	Y		Y		Y
ID0B180	Y		Y		Y
ID0B181	Y		Y		Y
ID0B182	Y		Y		Y
ID0B183	Y		N	Removed low disc	N

Item	24/02/06 Item inclusion	24/02/06 Item comment	06/04/06 Item inclusion	06/04/06 Item comment	7/04/06 Item inclusion
ID0B184	Y		Y		Y
ID0B185	Y		Y		Y
ID0B186	Y		Y		Y
ID0B187	N	Discrimination too low; other stats fine. [A] good distracter (small % of students of mean ability 0.05) selected A. Key is C. Relatively easy item.	N		N
ID0B188	N	% correct low; discrimination borderline. MC. Mean abilities spread across distracters somewhat [D is key and mean ability greatest], but suggests guessing.	N		N
ID0B189	N	% correct very low; discrimination borderline; favours girls (RUMM). Open item Difficult item. Requires written response. Pending overall gender DIF balance of pool.	N		N
ID0B190	Y	% correct high (very easy item); discrimination borderline. Suggests very familiar context. Pending no. of items of similar difficulty in pool.	Y		Y
ID0B191	N	Fit too high (RUMM); discrimination too low - check. Mean ability very similar for 0pt (0.20) and 1pt (0.28). Context overly familiar and potentially students confused as to how to answer?	N		N
ID0B192	Y	No issues.	Y		Y
ID0B193	Y	No issues.	Y	all good	Y
ID0B194	Y	% correct high (very easy item); discrimination borderline. EM item. Pending no. of items of similar difficulty in pool. Possibly provide in stimulus.	Y		N
ID0B195	Y	Favours NESB (RUMM); other stats fine. EM item. No apparent reason for why NESB would find this easier than nonNESB. Same construction as 1a and 1c (circle correct words).	Y		N
ID0B196	Y	% correct < 40; other stats fine. Would expect 1c to be more difficult than either of 1a or 1b.	Y	all good	N
ID0B197	Y	No issues.	Y		N
ID0B198	Y	No issues.	Y		N
ID0B199	Y		N	Remove unit post discussion	N
ID0B200	Y	note disc	N		N

Item	24/02/06 Item inclusion	24/02/06 Item comment	06/04/06 Item inclusion	06/04/06 Item comment	7/04/06 Item inclusion
ID0B201	Y	note disc	N		N
ID0B203	Y		N		N
ID0B204	Y		Y	agree on unit decisions	Y
ID0B205	N	low disc	N		N
ID0B206	N	note RUMM Chi-square (p) <0.05; reduce stimulus.	N		N
ID0B207	Y		Y		Y
ID0B208	Y		Y		Y
ID0B209	Y		Y		Y
ID0B210	N	potentially delete b	N		N
ID0B211	Y		Y		Y

Appendix D
Student Participation Form

NAP–SL STUDENT PARTICIPATION FORM (SPF)

The Student Participation Form (SPF) lists students registered to take part in the National Assessment Program – Science Literacy. Please complete Part A – Sampling Information (below) and Part B – Student Participation (overleaf). Please refer to page 9 of the Test Administrator's Manual for further details of how to complete this form.

School Name:
State/Territory:
School ID:
Class(es) involved:
Class practical task:

PART A – SAMPLING INFORMATION

(A) # Students in Year 6	(B) # Classes in Year 6	(C) Estimated Sample Size	(D) Enrolled Sample Size
____	____	____	____

Please sign below to acknowledge that you have checked the Test Booklets and Student Participation Form and that all is complete and in order. Don't forget to take a photocopy of both sides of this form and keep a copy for your records. Return the original with the test booklets.

School Contact Officer: Name: _____ Signature: _____

Test Administrator: Name: _____ Signature: _____

SPECIAL EDUCATION NEEDS (SEN) CODES (Column 7)	NON-INCLUSION CODES (Columns 9 & 11)	INDIGENOUS CODES (Column 5)
0 = No special education needs	10 = Absent	1 = Aboriginal but not Torres Strait Islander origin
1 = Functional disability	11 = Not included; functional disability	2 = Torres Strait Islander but not Aboriginal origin
2 = Intellectual disability	12 = Not included; intellectual disability	3 = Both Aboriginal and Torres Strait Islander origin
3 = Limited test language proficiency	13 = Not included; limited test language proficiency	4 = Neither Aboriginal nor Torres Strait Islander origin
	14 = Student or parent refusal	9 = Not stated/unknown
See full explanation on pages 9 and 10 of the Test Administrator's Manual		

PART B – STUDENT PARTICIPATION (Completed by the School Contact Officer & Test Administrator)

(1) Student ID	(2) Student name	(3) Booklet no.	(4) Sex M=male F=female	(5) Indigenous code (see overleaf)	(6) Birth date (DD-MM-YY)	(7) SEN code (see overleaf)	(8) **Objective test** Didn't complete = 0 Completed = 1	(9) Non-inclusion code (see overleaf)	(10) **Practical task** Didn't complete = 0 Completed = 1	(11) Non-inclusion code (see overleaf)
100–101										
100–102										
100–103										
100–104										
100–105										
100–106										
100–107										
100–108										
100–109										
100–110										
100–111										
100–112										
100–113										
100–114										
100–115										
100–116										
100–117										
100–118										
100–119										
100–120										
100–121										
100–122										
100–123										
100–124										
100–125										
100–126										
100–127										
100–128										
100–129										
100–130										
100–131										
100–132										
100–133										

Appendix E
Technical Notes on Sampling

Stratification details

For each jurisdiction, schools were separated into three separate strata according to their size: very small; moderately small; and large. The target proportion of students and number of schools selected within each of the strata were determined using the PISA (2003) treatment of small schools (pp. 53–56). Essentially, the aim was to balance selecting an adequate sample without substantially increasing the number of sampled schools.

Large schools within each jurisdiction were further separated according to their school sector. The target numbers of large schools were proportionally allocated amongst the school sectors for each jurisdiction. Very small and moderately small strata were sorted according to school sector, then by the remaining implicit stratification variables (Location and MOS). This strategy meant that the sampling frame was divided into 40 explicit strata overall. That is, there were 24 strata containing large schools (8 jurisdictions x 3 sectors); eight moderately small school strata (1 per jurisdiction); and eight very small school strata (1 per jurisdiction).

The stratification for small schools was slightly more complex than for large schools. Small schools were ordered by sector, GeoLocation and then gr06. The *sort order* was alternated so that 'like schools' were always nearby.

The stratum was sorted first by sector. Within each sector, schools were further sorted by GeoLocation. This sort order was alternated between ascending to descending between sectors (i.e. sector1 had GeoLocation sorted ascending, sector2 had GeoLocation sorted descending, sector3 had GeoLocation sorted ascending). The sort order for gr06 was then alternated from low to high, then low to high, each time a new sector/GeoLocation classification was encountered. **Table E.1** illustrates the sort-order procedures that were employed for small schools.

Table E.1 The sort ordering procedures employed for small schools

Sector	Geo location	ENR sort order
1	1	A
1	2	D
1	3	A
2	3	D
2	2	A
2	1	D
3	1	A
3	2	D
3	3	A

After small schools were stratified, the MOS for each school in the stratum was set equal to the average ENR of all schools within that particular stratum. This was equivalent to selecting a simple random sample of small schools. Such a strategy meant that very small schools would not be assigned excessively large sampling weights.

Random start and sampling interval values

Where *I* is the sampling interval ([stratum enrolment size]/[planned number of schools]) rounded to the nearest integer. **Table E.2** shows the starting values used to draw the sample for each explicit stratum.

Table E.2 Stratum variables for sample selection

Stratum	gro6size	Number of schools	Interval	Random start
ACT_Large_Cath	820	11	75	72
ACT_Large_Govt	2393	31	77	7
ACT_Large_Oth	553	7	79	65
ACT_ModSmall	515	8	64	26
ACT_VerySmall	83	2	42	25
NSW_Large_Cath	14 158	14	1011	280
NSW_Large_Govt	54 954	54	1018	997
NSW_Large_Oth	7801	8	975	674
NSW_ModSmall	6712	9	746	592
NSW_VerySmall	3336	7	477	270
NT _Large_Cath	253	3	84	27
NT _Large_Govt	1843.2	24	77	67
NT _Large_Oth	160	3	53	21
NT _ModSmall	363	7	52	10
NT _VerySmall	382	12	32	1

QLD_Large_Cath	7682	12	640	124
QLD_Large_Govt	36 937.4	57	648	396
QLD_Large_Oth	5033	8	629	585
QLD_ModSmall	3661.8	8	458	350
QLD_VerySmall	2397.3	8	300	152
SA _Large_Cath	2731	12	228	54
SA _Large_Govt	10 196.6	48	212	162
SA _Large_Oth	2331	10	233	129
SA _ModSmall	2579.5	16	161	36
SA _VerySmall	998.6	9	111	88
TAS_Large_Cath	699	6	117	115
TAS_Large_Govt	4101	36	114	60
TAS_Large_Oth	345	4	86	31
TAS_ModSmall	977	12	81	47
TAS_VerySmall	339.6	6	57	1
VIC_Large_Cath	11 699	16	731	264
VIC_Large_Govt	39 299.9	52	756	456
VIC_Large_Oth	4521	6	754	161
VIC_ModSmall	6463.8	11	588	71
VIC_VerySmall	2421.3	6	404	267
WA _Large_Cath	3967	12	331	74
WA _Large_Govt	17 098	53	323	14
WA _Large_Oth	2458	8	307	132
WA _ModSmall	2656	11	241	127
WA _VerySmall	1494	10	149	13

Appendix F
Programming Notes on Sampling

School index

An index was created that sequentially numbered schools starting from 1 in the order they appeared in '2005 Australian schools & student enrolments.xls'. This was the original 'sort order' for the file before any stratification occurred.

Missing GeoLocation values

Twenty-six schools did not have GeoLocation information supplied. MCEETYA codes for these schools were assumed to be the same as for other schools within similar postcode areas. The GeoLocation assigned to each of the 26 schools is shown in **Table F.1**.

Table F.1 Schools with estimated GeoLocation values

ID	MCEETYA code	State/ Territory	sector	gro6	inst_name
22837	1.2	ACT	Other	4	Islamic School of Canberra
24012	2.1.2	NSW	Govt	22	North East Public School of Distance Education
24011	1.2	NSW	Govt	11	Shell Cove Public School
24010	1.1	NSW	Govt	11	Woongarrah Public School
17129	1.1	NSW	Other	7	The American International School
22886	1.1	NSW	Govt	3	Ironbark Ridge Public School
24013	3.1	NT	Govt	1	Manyallaluk School
18221	2.1.2	QLD	Cath	10	St Francis Catholic Primary School
16612	2.2.2	QLD	Other	3	Hinchinbrook Christian School
18219	1.2	QLD	Other	2	Gold Coast Montessori College
22818	1.1	SA	Other	18	Sunrise Christian School
22798	2.2.2	SA	Other	11	Mid North Christian College

18028	1.1	VIC	Govt	19	Lynbrook Primary School
18061	1.1	VIC	Govt	13	Roxburgh Rise Primary School
18030	1.1	VIC	Govt	10	Strathaird Primary School
18027	2.1.1	VIC	Cath	4	Frayne College
18026	2.1.2	VIC	Cath	3	St Luke's Catholic Primary School
22840	1.1	VIC	Other	3	Bryngala College
18051	1.1	WA	Govt	65	Carramar Primary School
18050	1.1	WA	Govt	46	Rawlinson Primary School
22830	1.1	WA	Govt	28	Caralee Community School
18049	1.1	WA	Govt	24	Excelsior Primary School
24015	1.1	WA	Govt	21	Ashdale Primary School
23793	1.1	WA	Govt	21	Settlers Primary School
18056	2.1.2	WA	Cath	16	Dawesville Catholic Primary School
22828	3.1	WA	Govt	1	Gascoyne Junction Remedial Community School

F.1. SPSS syntax for sample selection

```
*=================================================================
ENRSIZE was the MOS to be assigned to schools in small school stratums
STRATA is the stratum being sampled
RANDM is the random starting value for the stratum
CONST is the sampling interval for the stratum
*=================================================================.
*========================================
        PPS SAMPLE MACRO
*========================================.
DEFINE !SAMPLE (enrsize = !DEFAULT(999) !TOKENS(1)
                / strata = !TOKENS(1)
                / randm = !TOKENS(1)
                / const = !TOKENS(1)).

GET FILE='SampleFrame.sav'.

*=======SELECT STRATUM=======.
select if (RTRIM(Stratum)=!strata).
exe.
SORT CASES BY StateId (A) SectorId (A) GeoId (A) gr06 (A) .

*=======IDENTIFY SUBGROUPS=======.
if ($casenum = 1) stratumsort = 1.
do if (sectorid = lag(sectorid) and geoid = lag(geoid)).
        compute stratumsort = lag(stratumsort).
else.
        compute stratumsort = lag(stratumsort) + 1.
end if.
exe.

*=======STRATIFY SUBGROUPS=======.
!IF (!enrsize = 999)!THEN.
        *=======LARGE SCHOOL SORT=======.
        title 'Large school sort'.
        do if (MOD(stratumsort,2) > 0).
                compute sort2 = stratumsort * 1000 + gr06.
        else.
                compute sort2 = stratumsort * 1000 - gr06.
        end if.
        exe.
```

```
!ELSE.
        *=======SMALL SCHOOL SORT=======.
        title 'Small school sort'.
        do if (MOD(sectorid,2) > 0).
                compute sort1 = sectorid * 100 + stratumsort.
        else.
                compute sort1 = sectorid * 100 - stratumsort.
        end if.
        RANK
         VARIABLES=sort1 (A) /RANK /PRINT=YES
         /TIES=CONDENSE .
        do if (MOD(Rsort1,2) > 0).
                compute sort2 = Rsort1 * 1000 + gr06.
        else.
                compute sort2 = Rsort1 * 1000 - gr06.
        end if.
        exe.
        compute tmpgr06 = gr06.
        compute gr06 = !enrsize.
!IFEND.
SORT CASES BY Sort2 (A).

*=======SET VERY LARGE SCHOOLS EQUAL TO THE SAMPLING INTERVAL=======.
if (gr06>!const) gr06 = !const.
exe.

*=======RANDOMLY SELECT SCHOOLS WITH PPS=======.
*=======SYNTAX FOR THIS SECTION TAKEN FROM ROSS IIEP (1997) NOTES=======.
compute ranstart = !randm.
compute interval = !const.
compute case = $casenum.
exe.

if ($casenum = 1) ticket1 = 1.
if ($casenum = 1) ticket2 = gr06.
if ($casenum > 1) ticket1 = lag(ticket2) + 1.
if ($casenum > 1) ticket2 = lag(ticket2) + gr06.
if ($casenum = 1) selector = ranstart.
if ($casenum > 1) selector = lag(selector).
string select (a3).
compute select = '___'.
if (ticket1 <= selector and selector <= ticket2) select = 'YES'.
if (select = 'YES') selector = selector + interval.
```

```
*HANDLE FOR LARGE SCHOOLS.
if (select = 'YES' and selector < ticket2) select = 'SOS'.
exe.

if ($casenum = 1) wintickt=ranstart.
if ($casenum > 1) wintickt=lag(selector).
exe.

*=======SELECT REPLACEMENT SCHOOLS=======.
DO IF ((lag(select)='YES' or lag(select)='SOS') and select = '___').
        compute select = 'R_1'.
        compute replaceid = lag(schoolid).
END IF.
DO IF ((lag(select,2)='YES' or lag(select,2)='SOS') and select = '___' and lag($casenum,2)=1).
        compute select = 'R_2'.
        compute replaceid = lag(schoolid,2).
END IF.
SORT CASES BY case (D) .
DO IF ((lag(select)='YES' or lag(select)='SOS') and select = '___').
        compute select = 'R_2'.
        compute replaceid = lag(schoolid).
END IF.
DO IF ((lag(select,2)='YES' or lag(select,2)='SOS') and select = '___' and lag($casenum,2)=1).
        compute select = 'R_1'.
        compute replaceid = lag(schoolid,2).
END IF.
SORT CASES BY case (A) .
if (select = 'YES' or select = 'SOS') replaceid = schoolid.
exe.
SAVE OUTFILE=!QUOTE(!CONCAT('All_',!UNQUOTE(!strata) , '.sav')).

*=======KEEP SAMPLED AND REPLACEMENT SCHOOLS=======.
set width = 120.
set length = 1000.
title Schools Selected from the Specified Stratum !strata.
select if (select='YES' or select='SOS').
list var=inst_name stratum gr06 ticket1 ticket2 wintickt select / format = numbered.
title.
SAVE OUTFILE=!QUOTE(!CONCAT('Sample_',!UNQUOTE(!strata) , '.sav')).

!ENDDEFINE.
```

Appendix G
Characteristics of the Proposed 2006 Sample

It was desirable that the magnitude of sampling errors was similar between jurisdictions. Whilst equal sample sizes were initially assigned to each jurisdiction, the sample sizes were reduced for the ACT, NT and TAS given their relatively smaller populations. The proportion of students sampled across each jurisdiction is detailed in **Table G.1**. For example, approximately 15% of the total sample of students was to be drawn from NSW.

Table G.1 Number of schools and students to be sampled in each jurisdiction

State/ Territory	Number of sampled schools[18]	Number of sampled students[19]	Percentage of total population of students sampled
ACT	57	1345	9%
NSW	92	2104	15%
NT	49	932	7%
QLD	94	2116	15%
SA	94	2087	15%
TAS	64	1397	10%
VIC	91	2098	15%
WA	95	2093	15%
Total	636	14 172	100%

[18] These are the number of schools sampled. Not all the sampled schools have participated. Of these 636 schools, 15 schools did not participate in the testing (and could not be replaced).
[19] These are the number of students enrolled according to the sampling frame. These differ slightly from the numbers shown in **Table 3.7**, where the number of students are those enrolled at *the time of testing*.

Within each jurisdiction, the number of students sampled was allocated proportionally across the sectors according to the sector population proportions (see **Table G.2**).

Table G.2 Comparison of proposed sample and population sector proportions across jurisdictions

State/ Territory	Sector	Population			Proposed sample			Difference (population – sample) proportions
		Schools	Students	Sector proportions	Schools	Students	Sector proportions	
ACT	Cath	23	991	23%	13	317	24%	–1%
	Govt	73	2772	64%	37	875	65%	–2%
	Other	12	601	14%	7	153	11%	2%
	Total	108	4364	100%	57	1345	100%	0%
NSW	Cath	421	16 190	19%	17	389	18%	0%
	Govt	1658	61 542	71%	65	1488	71%	0%
	Other	266	9229	11%	10	227	11%	0%
	Total	2345	86 961	100%	92	2104	100%	0%
NT	Cath	8	287	10%	4	89	10%	0%
	Govt	124	2414	80%	40	739	79%	1%
	Other	16	300	10%	5	104	11%	–1%
	Total	148	3001	100%	49	932	100%	0%
QLD	Cath	209	8626	15%	14	327	15%	0%
	Govt	1023	41 312	74%	70	1568	74%	0%
	Other	146	5774	10%	10	221	10%	0%
	Total	1378	55 712	100%	94	2116	100%	0%
SA	Cath	77	3114	17%	14	335	16%	0%
	Govt	459	12 957	69%	67	1464	70%	–1%
	Other	82	2766	15%	13	288	14%	1%
	Total	618	18 837	100%	94	2087	100%	0%
TAS	Cath	29	900	14%	8	175	13%	1%
	Govt	170	5042	78%	50	1102	79%	–1%
	Other	24	520	8%	6	120	9%	–1%
	Total	223	6462	100%	64	1397	100%	0%
VIC	Cath	386	13 738	21%	20	461	22%	–1%
	Govt	1262	45 379	70%	64	1482	71%	0%
	Other	157	5288	8%	7	155	7%	1%
	Total	1805	64 405	100%	91	2098	100%	0%
WA	Cath	125	4526	16%	15	349	17%	0%
	Govt	638	20 143	73%	68	1501	72%	1%
	Other	109	3004	11%	12	243	12%	–1%
	Total	872	27 673	100%	95	2093	100%	0%
Total	Cath	1278	48 372	18%	105	2442	17%	1%
	Govt	5407	191 561	72%	461	10 219	72%	0%
	Other	812	27 482	10%	70	1511	11%	0%
	Total	7497	267 414	100%	636	14 172	100%	0%

Schools were also classified according to their enrolment size. Very small schools were slightly under-sampled while moderately small and large schools were slightly over-sampled. This approach was adopted to ensure that an adequate number of students would be surveyed while still ensuring very small schools would be represented without vastly increasing the overall number of schools sampled.

Table G.3 Comparison of population and proposed sample proportions according to school size

School size	Population			Proposed sample		
	Schools	Students	Proportion of students by school size	Schools	Students	Proportion of students by school size
Large	4244	232 034	87%	492	12 300	87%
Moderately small	1291	23 928	9%	82	1510	11%
Very small	1962	11 452	4%	62	362	3%
Total	7497	267 414	100%	636	14 172	100%

Appendix H
Variables in File

Table H.1 NAPSL2006_Reporting_WLE_PV_20070423.sav

Variable names	Description
RS1 to RS110	Recoded student responses, as defined for the calibration sample
Final weight	Student final sampling weight
RW0	Same as final weight
RW1 to RW310	Jackknife replicate weight

Appendix I
ConQuest Control File for Producing Plausible Values

Table I.1 File Name: ProducePV.cqc

```
Data ../FinalData/ItemsAllForConQuest.dat ;
format responses 1-81,83-110 bookid 120 PWeight 121-130 SchWLE 131-140
 State1 141
 State2 142
 State3 143
 State4 144
 State5 145
 State6 146
 State7 147
 Gender1 148
 Gender2 149
 ATSI1 150
 ATSI2 151
 Sector1 152
 Sector2 153
 Geolocation1 154
 Geolocation2 155
 Geolocation3 156
 Geolocation4 157
 Geolocation5 158
 Geolocation6 159
 Geolocation7 160;
set constraint=none;
Set n_plausible=10;
caseweight pweight;
key
12311112414341111123423131211441413112111313231132212141111111111111412211141111121421131113113
1111111111112 !1;
key
```

```
xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx2xxxx2xxxxxxxxx
xxxxxxxxxxxxxxxxxx !2;
codes 0,1,2,3,4,5,6,7,8,9,A;
import anchor_param << itemparam.anc;
labels << Run1All2.lab;
model bookid + item + item*step;
regression
 SchWLE
 State1
 State2
 State3
 State4
 State5
 State6
 State7
 Gender1
 Gender2
 ATSI1
 ATSI2
 Sector1
 Sector2
 Geolocation1
 Geolocation2
 Geolocation3
 Geolocation4
 Geolocation5
 Geolocation6
 Geolocation7 ;
estimate !fit=no, nodes=30;
show !estimate=latent >> ConQuestScaling.shw;
itanal >> ConQuestScaling.itn;
show cases !estimate=latent >> ConQuestScaling.pls;
show cases !estimate=WLE >> ConQuestScaling.wle;
```